National Airspace System Capital Investment Plan

FY2010–2014

2009-AJG-101

Federal Aviation Administration

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Federal Aviation Administration National Airspace System Capital Investment Plan for Fiscal Years 2010–2014

1 Introduction

1.1 The Capital Investment Plan

The Federal Aviation Administration (FAA) Capital Investment Plan (CIP) shows the planned investment to sustain the existing National Airspace System (NAS) for the next 5 years and to continue the transition to the Next Generation Air Transportation System (NextGen) based on the projected levels of funding. The CIP fulfills our obligation, that is contained in annual appropriations laws, to transmit to the Congress a comprehensive capital investment plan for the FAA which includes funding for each budget line item for 5 years, with total funding for each year of the plan constrained to the funding targets included in the President's Budget Request.

The planned project activities in this CIP are consistent with the President's Fiscal Year (FY) 2010 budget request. Funding estimates for budget line items are based on several factors. For the large capital investment projects, the estimated funding is the amount for fulfilling commitments in the acquisition contract and the associated project support costs. For infrastructure improvements, the estimated funding is either the estimated cost for specific locations or the annual amounts allocated to upgrade existing facilities and equipment based on facility condition surveys.

1.2 Strategic Planning and the CIP

FAA's Flight Plan 2009–2013 is our strategic plan. It is developed to articulate the most important goals for judging our performance in delivering services. These goals guide us in improving NAS performance and adjusting operations to meet the demands placed on the NAS by future growth. Our strategic goals are augmented by objectives, strategies, and supporting initiatives that define the actions to achieve them. The objectives have measurable performance targets to assess our progress. Our actual performance is regularly compared to the established targets to ensure that our strategies and initiatives are successful so that we can quickly make adjustments when they are not producing the expected results.

The current FAA Flight Plan identifies four specific goal areas:

- **Increased Safety —** To achieve the lowest possible accident rate and constantly improve safety;
- **Greater Capacity —** Work with local governments and airspace users to provide increased capacity and better operational performance in the United States airspace system that reduces congestion and meets projected demand in an environmentally sound manner;
- **International Leadership —** Increase the safety and capacity of the global civil aerospace system in an environmentally sound manner; and
- **Organizational Excellence —** Ensure the success of the FAA's mission through stronger leadership, a better trained and safer workforce, enhanced cost-control measures, and improved decision-making based on reliable data.

The CIP projects, by design, seek to support the goals, objectives, and performance targets in the Department of Transportation's (DOT) strategic plan and the FAA Flight Plan 2009–2013. Many FAA projects will contribute to more than one goal, objective, or performance target; however, the project linkages in the CIP (appendices A and B) connect each project to the single goal, objective, and performance target where that project's contribution is most significant. We list several projects under each performance measure for several reasons. Many projects are interdependent, and one project may not be successful in meeting a performance target without completion of other supporting projects. Also, in the complex system used for air traffic control, system improvements must address several different operating conditions to reach the overall performance target, and often it takes multiple projects to address each of the variables, which individually contribute to overall system inefficiencies. Only CIP projects with FY 2010–2014 funding are included in appendices A, B, and C.

The CIP connects projects to the six goal areas of the DOT Strategic Plan, which is broader than the FAA's Flight Plan that has four Strategic Goals. The Flight Plan incorporates Environmental Stewardship projects into the Increased Capacity goal and the Security, Preparedness and Response projects into the Organizational Excellence goal as shown below. This document aligns projects to all six DOT goals to show specifically which projects support DOT environmental and security goals.

The six DOT Strategic Goals are: **The four FAA Strategic Goals are:**

1. Safety…………………………………………………....Increased Safety
2. Reduce Congestion……………………………………..Greater Capacity
3. Global Connectivity…………………………………….International Leadership
4. Environmental Stewardship…………………………….(*Greater Capacity*)
5. Security, Preparedness and Response…………………..(*Organizational Excellence*)
6. Organizational Excellence………………………………Organizational Excellence

The detailed project information in appendix B provides more insight into the strategic purpose of projects by including a "Relationship of Program to FAA Strategic Goal, Objective, and

Performance Target" section that gives more specific information about how each project helps meet a Flight Plan goal.

1.3 Management Process for Selecting Modernization Projects

In addition to relating capital investment to agency strategic goals, FAA management must have a disciplined process for managing modernization. We have established a detailed process for evaluating, approving, and managing projects. When management considers a project for funding, it must have a business case that estimates both project cost and benefits. A Capital Investment Team composed of representatives of all the major lines of business reviews this business case as warranted. If the team believes the project has merit, it recommends that the Senior Vice-President – Finance approve it before presenting the project to the Executive Council (EC) and the Joint Resources Council (JRC), which consist of FAA's top executives. Once the JRC approves a project, a baseline cost estimate is established, and the FAA commits to fully fund that baseline, so projected benefits are not lost because the project cannot be implemented consistent with its planned schedule.

As requested by the Government Accountability Office, we have added Appendix D to this CIP to show a list of programs that have experienced baseline changes and the impact of those changes. There normally are two reasons for increases in a project's baseline. If annual funding is below the established baseline, the project schedule is extended, and that results in increased costs because the added years require inflation adjustments to labor rates, and the labor hours used exceed the baseline estimates. The other reason for baseline increases is that the project encounters unforeseen problems that require additional engineering design and production time sometimes accompanied by the need for more elaborate site preparation for system installation.

To manage projects to stay within the established baselines, project oversight must continue after initial approval. This includes regular program reviews of progress and assessment of the project's potential to deliver the planned benefits within the estimated cost envelope by the JRC. Projects that are over cost and/or behind schedule can be restructured or cancelled. To accommodate any necessary changes, the Capital Investment Plan financial baseline must be updated regularly and reflect these adjustments as we continue to seek the best solutions to expanding capacity and improving efficiency of air traffic services.

Appendices B and C detail the near-term capital investments, but we must also consider the longer term modernization needs. Section 3 shows the planning for operational improvements that are part of the NextGen system, and Section 4 contains the roadmaps that system engineers have developed that translate those improvements into hardware and software changes. These roadmaps help engineers look at the broader system engineering issues to ensure that efforts are integrated as several systems are enhanced simultaneously. They also identify the interactions among those systems to ensure that as modern systems replace the older systems, the air traffic control system will continue to function smoothly.

1.4 Important Factors Affecting Planning for the Future

1.4.1 Nature of Capital Investment

Capital investments normally require extensive planning and development. They often take several years to implement, and, after development, require extensive testing before any operational improvements or gains in efficiencies become effective. Thus, project managers must plan for the operating environment forecast for 4 to 5 years in the future rather than meeting only present needs. The FAA prepares a detailed forecast of future aviation activity every year to help project managers determine the future operating environment. The following section discusses some of the considerations that have led to our commitment to pursue NextGen solutions to provide the system of the future.

In addition to increasing aviation capacity by implementing NextGen, we must recognize the impact of our Nation's air transportation industry on economic growth. A recent study by the Air Traffic Organization (ATO) Performance Analysis and Strategy Service Unit, "The Economic Impact of Civil Aviation on the U.S. Economy," published in October 2008, estimates that aviation accounted for over $1.2 trillion in economic activity in 2006, which represents 5.6 percent of the total U.S. economic activity. It created an estimated 11 million aviation-related jobs and flew over 39 billion revenue ton-miles of air cargo. A reliable worldwide aviation network is essential for today's economy. Domestic and international commerce rely on the access and passenger and freight capacity it provides to cities around the world to sustain economic growth.

1.4.2 Air Travel Demand

The demand for air travel is closely related to changes in the economy. As Figure 1 shows, the growth in revenue passenger miles (RPM) over the last 30 years corresponds positively with the growth in inflation-adjusted GDP. Our inflation-adjusted (real) economic output has a long-term growth trend that supports the increases in the number of passengers and the miles traveled. There are some minor deviations in both the GDP and RPM growth line, which are caused by abnormal events, such as the terrorist attacks of September 11, 2001. It is our judgment, however, that the long-term economic growth trend is likely to continue upward after a period of adjustment because such factors as population growth, increases in productivity, and introduction of new technology will foster growth. It follows that increased demand for air travel will track that increased economic growth. Growth in air travel demand will lead to more aircraft operations, which translates into increased workload for the FAA. It also translates into more pressure on the 35 Operational Evolution Partnership (OEP) airports to handle additional operations. Significant increases in operations at these airports will increase delays, unless we implement the advanced NextGen capabilities to provide the improved services to handle this growth.

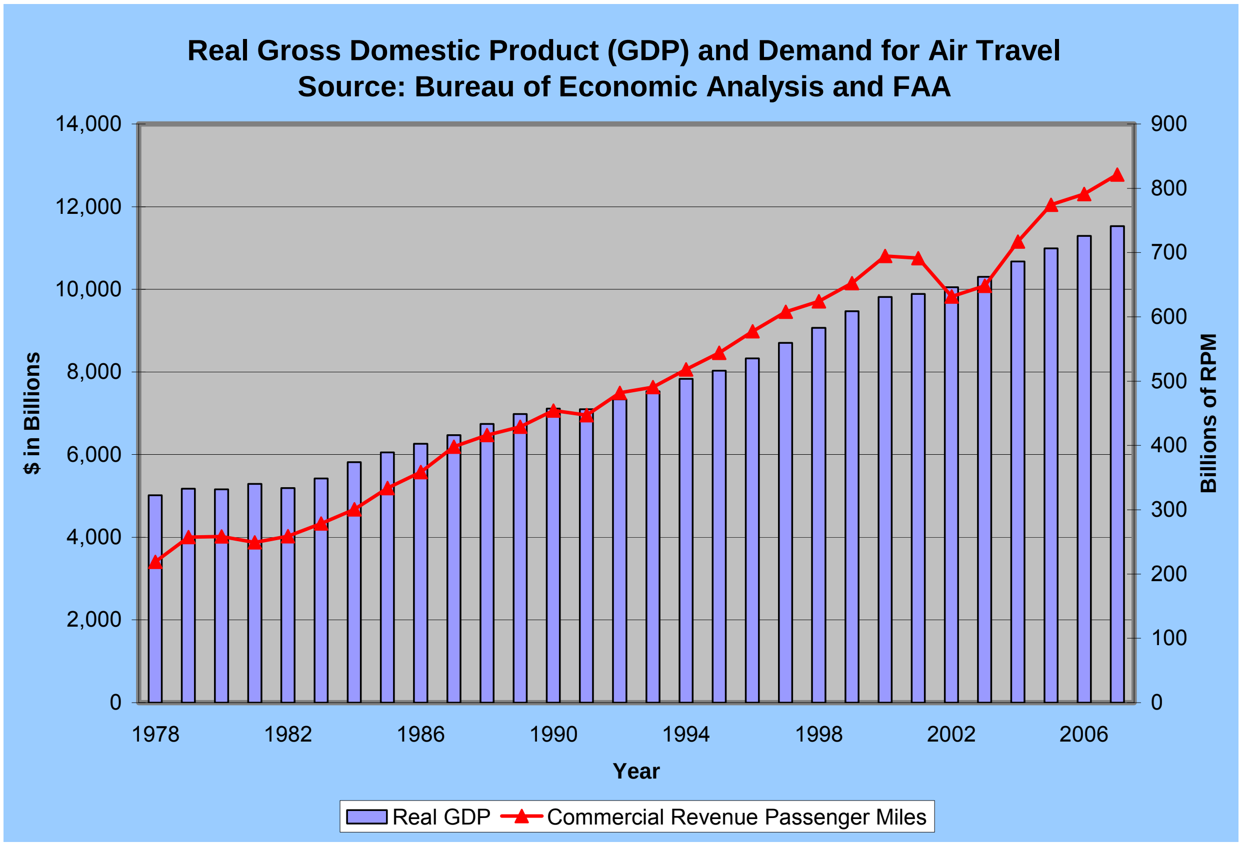


Figure 1 Air Travel Demand Growth Compared to Growth in GDP

1.4.3 Growth in En Route Operations

Figure 2 shows growth in the number of aircraft handled by en route centers and that this upward trend is consistent with the growth trend for RPM. The percentage of air traffic growth has been slower than the growth in RPM, but that may change in the future. In the past, airlines were able to meet a portion of the increased demand for air travel by buying larger aircraft with more seats and by increasing load factors. Operational considerations and costs will limit the amount of demand absorbed in that manner in the future as carriers try to match aircraft size more closely to market demand. A portion of increased future demand will be met with additional operations.

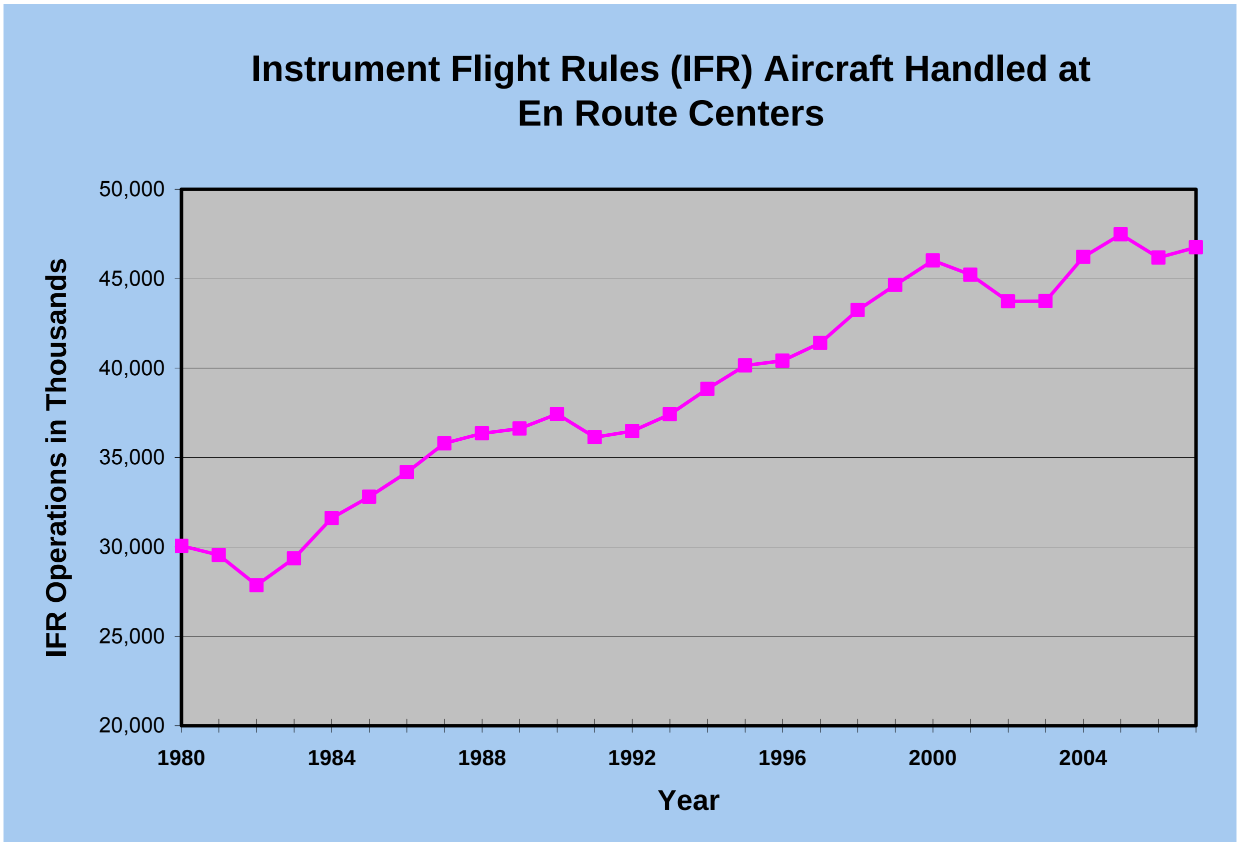


Figure 2 Historical Growth — Number of Aircraft Handled by En Route Centers

Since 2001, legacy air carriers have made adjustments to shift larger aircraft to long-haul routes and serve international markets that increase aircraft utilization and maximize their revenue yield. The smaller markets are either served by regional carriers under contract to the legacy carriers or abandoned altogether. When regional carriers serve these shorter routes, they fly smaller jets, which create more operations for the same number of passengers.

The FAA Aerospace Forecast Fiscal Years 2009-2025 states, "The latest set of economic forecasts from the Administration calls for the U.S. recession to end by the third quarter of FY 2009 followed by a relatively modest recovery over the next six quarters." Commercial aviation flights and travel demand are forecast to fall sharply in 2009, but growth is projected to return in 2010 with revenue passenger miles increasing 2.8 percent and the number of passengers increasing by 2.0 percent. The current forecast also assumes business use of general aviation aircraft will expand as growth in the economy returns. Reduction in the number of aircraft flown and in fuel prices will improve chances for commercial aviation to regain profitability and resume growth. As shown in Figure 2, past downturns in aircraft operations were usually short lived, and the recovery surpassed previous levels.

The nature of the current downturn suggests that recovery will be slower than it was in past downturns and the strength of the recovery more muted. However, as we pointed out in section 1.4.1, we must plan for the long-term when we are considering capital investments. Congestion and delays will increase if the FAA does not complete modernization in time to use airspace capacity more efficiently.

Another long-term factor that affects the need for capital investment is the continuing effort to increase airport capacity, especially at the larger airports. Some of these airports have been able to increase capacity by building new runways, and, as a result, 13 new runways have become operational since 2000. The NextGen Integration and Implementation Office has identified 12 more airfield projects that would be beneficial.

When local airport authorities build new runways or otherwise expand capacity, the FAA must add supporting equipment and develop procedures to make that capacity fully usable. When new runways are built, airspace around the airports is often reconfigured to accommodate new approach and departure patterns. This normally requires installing new navigational aids and precision landing systems to help pilots in the approach patterns for the runways. Before precision approach guidance systems become operational, the FAA must install approach lights, and position visibility sensors along the runway so that precision guidance can be used down to the lowest visibility approved for that system. Some airports need new surface surveillance systems to alert pilots to potential runway incursions and to help pilots negotiate complex airport taxiway and runway configurations. We also need capital investment to expand air traffic control facilities and add additional controller positions to handle the increased complexity of terminal airspace after a new runway is opened.

2 Key Considerations in Capital Planning

Capital planning requires careful balancing to satisfy competing needs over the next several years. We must ensure that the present system continues delivering highly reliable performance to support operations while we are preparing for the more capable system needed to sustain future growth. This requires allocating our expenditures between sustaining current operational facilities and equipment and investing in new technology and improved delivery of services.

2.1.1 Sustaining Current System Performance

The air traffic control system requires very high reliability and availability. Once an aircraft is airborne, the FAA must maintain constant contact with the aircraft and be able to provide separation service for the entire flight from takeoff to landing. Each system in the NAS has a high level of redundancy to support system reliability that will prevent service disruptions. The FAA must replace equipment on a scheduled basis to minimize failures and prevent deterioration in system performance.

There are nearly 60,000 NAS operational facilities that support Air Traffic Control (ATC) and over 500 large buildings that house major ATC functions. Upgrading and replacing facilities and equipment to sustain performance requires over $1.5 billion per year. Problems with buildings or the equipment they house can result in expensive disruptions in air traffic control.

2.1.2 Making Interim Upgrades to Existing Equipment

In addition to replacing critical facilities and equipment, the FAA must also regularly upgrade them. Since many systems now rely on commercial-off-the-shelf (COTS) hardware and software, we must continually keep pace with upgrades. Normally each upgrade depends on the previous release by the manufacturer, and skipping an upgrade is not an option.

Electronic components and computer systems become obsolete and sometimes must be replaced because manufacturers no longer produce repair parts. In other cases, replacing components in one set of equipment can require changes in connected equipment that sends information to or receives information from the obsolescent part being replaced. Examples of systems that the FAA is upgrading are the large displays that controllers use to maintain aircraft separation and the voice switches that allow controllers access to the many voice channels that they use to communicate with pilots and each other.

Many components of the air traffic control system exchange information with aircraft. As newer aircraft come into service and older aircraft have their avionics upgraded, the FAA will upgrade its equipment to take advantage of improvements in communication, navigation, and surveillance technology. These changes improve the accuracy of the information exchange, which improves FAA productivity.

An additional motivation for the FAA to replace equipment is the pressing need to reduce operating costs. The payback period for energy-saving devices can be as short as 1 or 2 years, so it is often economical for the FAA to replace equipment in the short term while designing and testing NextGen systems. There is also increasing pressure to lower emissions, which is tied to the accompanying goal of reducing energy consumption. Funding for these projects will continue until the savings no longer exceeds the cost.

The Next Generation Air Transportation System (NextGen) is the ultimate solution for fully modernizing air traffic control. The current system will not allow significant increases in capacity at busy airports. Growth in aviation will require new systems and procedures to accommodate the increased demand for capacity. We must also develop the skills to transition to NextGen, which will transform the existing system into one with advanced capabilities.

2.2 NextGen Investments

The fiscal year 2010 budget includes over $350 million to deploy foundational technologies and infrastructure, including Automatic Dependent Surveillance - Broadcast (ADS-B), Data Communications (DataComm), NextGen Network Enabled Weather (NNEW), NAS Voice Switch (NVS) and System Wide Information Management (SWIM). These are core technologies to introduce new capabilities promised for NextGen. They provide the communication, navigation, and surveillance technology supported by the more sophisticated information flows that will allow better use of airspace capacity.

The FAA will use additional NextGen funding to implement the NextGen solution sets (e.g., trajectory-based operations, high-density arrivals and departures, and five others). In some cases, these projects will develop and buy new equipment; in other cases, FAA will use the funds for demonstrations to prove that the new technology is accurate and reliable enough to use operationally. Future investments in improved communications, navigation, surveillance, and automation systems will implement the new technology, which will allow use of less separation between aircraft and result in capacity expansion.

This CIP shows that the transition to NextGen is well underway. We will be increasing spending over the next several years (see figure 3). We are carefully planning a responsible transformation of the existing air traffic control system to a newer system with far greater capabilities while maintaining the current system at peak operational performance. As we complete some of the existing CIP programs during this period, increased amounts of funding will be available for NextGen development and implementation.

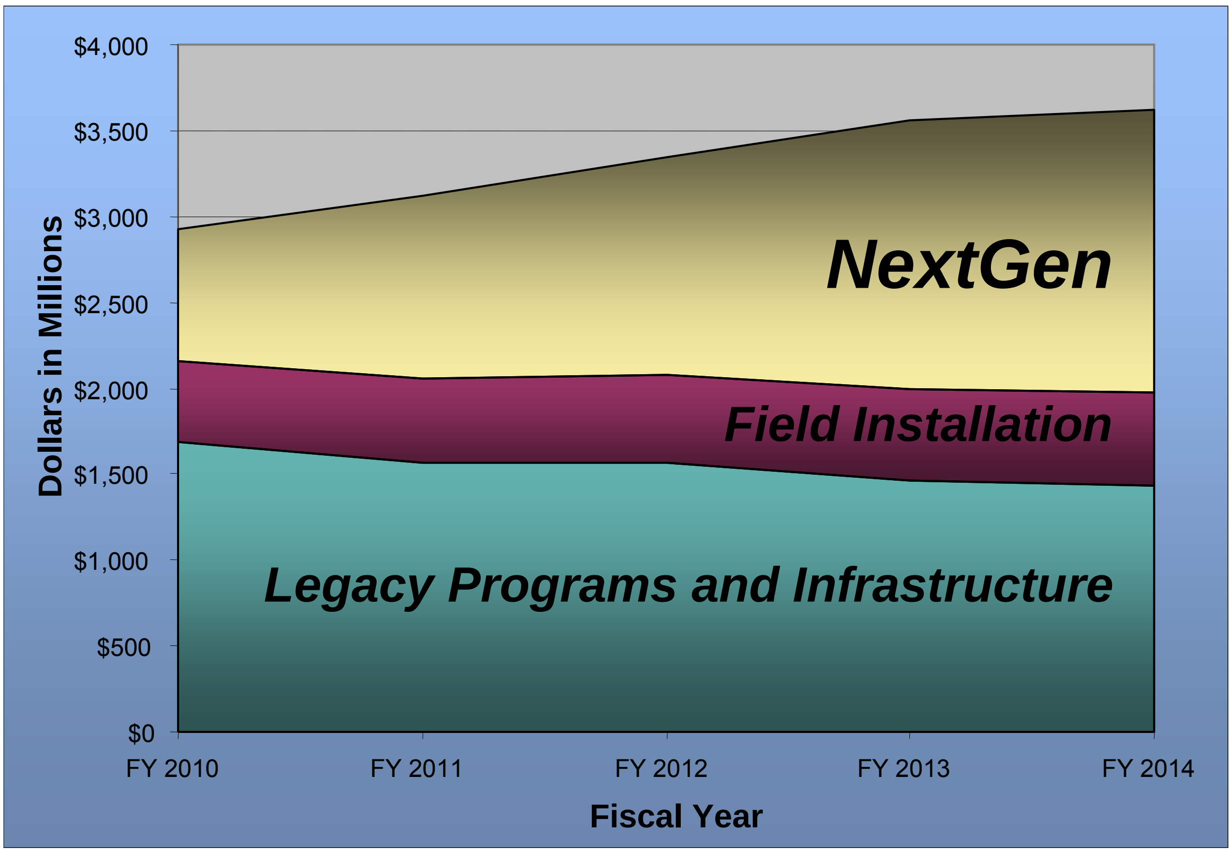


Figure 3 NextGen Portfolio Relative to the Total Capital Request

2.3 Major Initiatives in FY 2010 Budget

The areas and specific projects that we discuss below are the special initiatives funded in FY 2010 that address safety, capacity, and environmental issues. These are high-priority projects that address aviation challenges and reflect our best efforts to find solutions to them.

2.3.1 Safety

In FY 2010, the FAA is focusing on eliminating runway incursions by implementing Runway Status Lights and Airport Surface Detection Equipment – Model X (ASDE-X) while developing the Low Cost Ground Surveillance System (LCGS).

The Runway Status Light Program is requesting a large increase over FY 2009 requested funds ($27.0M to $117.3M) to implement these systems at an additional 20 airports. These systems of embedded lights in the taxiway and runway have been tested at two major airports and have been successful in warning pilots to not enter active runways when it would be unsafe to do so. To continue our success in reducing serious runway incursion incidents, we have decided to increase the number of airports that will benefit from these systems.

The ASDE-X program is well underway, and we have provided funding in FY 2010 to finish installing these airport surface detection systems. These systems provide airport operating area status to controllers and also transmit the information that operates the Runway Status Lights. ASDE-X displays in the airport tower show controllers the location of aircraft and ground vehicles near and on the taxiways and runways, so controllers can take swift action to prevent potential runway incursions.

The FAA is building prototypes of the LCGS system under the Runway Incursion Reduction Program in FY 2009 and will be testing them in FY 2010. If testing is successful, the LCGS could be used to reduce runway incursions at lower activity airports. The ASDE-X system, which is installed at larger airports, is not appropriate for these smaller airports, but the lower cost LCGS would provide equivalent protection against runway incursions.

2.3.2 Capacity

Airspace redesign has proven to be effective in enabling air traffic controllers to use airspace surrounding major airports more efficiently. Work is continuing on the New York/New Jersey airspace redesign, and when parties reach an agreement on implementing it, the estimated delay reduction is 20 percent. There is also airspace redesign for the Chicago area. The planned expansion and reconfiguration of the runways at Chicago's O'Hare Airport will generate significant benefits when additional arrival and departure routes are created to take advantage of the increased runway capacity.

We have substantially increased the investment for replacing and upgrading electrical power systems in the FY 2010 budget. These systems condition the power that runs the automation, communication, navigation, and surveillance systems used for air traffic control, and they can generate electricity when commercial power fails or accidents cut off power. Because air traffic control is so time critical, FAA facilities require exceptional reliability and stability, and power systems ensure that performance when commercial power sources fail. Preventing system outages avoids delaying or diverting aircraft, because outages normally result in significant decreases in capacity. We must also modernize and upgrade electrical power systems to protect against lightning strikes. Studies show that higher levels of spending are necessary to sustain the high performance of our electrical power systems.

2.3.3 Fuel Savings and Environment

One of the significant concerns about aviation growth is its impact on the environment. Past technological developments have led to reduced aircraft noise and emissions. However, we need continuing improvements to address and resolve aviation's environmental impacts — including noise, air quality, water quality, global climate effects, and related energy issues. Environmental and energy concerns, if not adequately managed, are likely to constrain aviation growth.

Airframe and engine manufactures are continuing their efforts to improve the fuel efficiency of aircraft. Improved fuel efficiency benefits the environment by reducing jet engine emissions because less fuel is consumed per flight, and it has the added benefit of reducing costs for airlines and other operators. In addition to manufacturers, commercial operators — for economic as well as environmental reasons—have a strong motivation to decrease fuel consumption and related emissions from aircraft. Testing is currently underway at Atlanta and Miami to determine how to implement Continuous Descent Approaches, which minimize fuel consumption as aircraft descend to land. Capabilities that we will develop under NextGen will play a significant role in reducing aircraft noise and emissions.

Manufacturers and users will implement the technological advances developed under the Continuous Low Energy, Emissions, and Noise (CLEEN) program for aircraft design and sustainable alternative fuels. We will invest in demonstrating integration of these capabilities and assessing system wide environmental benefits. New procedures supported by NextGen capabilities will decrease noise and emission impacts and increase air traffic control efficiency. By planning for and ensuring that aircraft fly shorter, more efficient routes, there is a double benefit: lower emissions and lower fuel consumption. Trajectory-Based Operations and High Density arrival and Departure initiatives will reduce distance traveled and decrease maneuvering in the terminal area to save both time and fuel. The FAA will also explore environmental control algorithms for ground, terminal area, and en route advanced operational procedures to reduce fuel burn, emissions, and noise.

3 Next Generation Air Transportation System

Over the last 20 years, the FAA has significantly modernized the existing air traffic control system. By both improving equipment and adding a robust strategic planning capability at the Air Traffic Control System Command Center, the agency has markedly improved its ability to handle the flow of air traffic. However, we anticipate reaching the limits of improving the current system in the near future. With more aviation growth on the horizon, the FAA must implement new ways of managing the predicted air traffic volume. The Next Generation Air Transportation System (NextGen) replaces and expands the current system's capabilities.

The NextGen effort to increase capacity began with operational specialists describing operational improvements that would improve the system's capability to handle more aircraft. These operational improvements are changes in air traffic control procedures that result from increasing the accuracy of navigation and surveillance systems or increasing the rate of information flows to the upgraded decision support tools within the ATC equipment. The increases in capacity occur because both the system capability upgrades and the fundamental changes in technology greatly enhance our ability to handle air traffic.

Once we identify the operational improvements, engineers must ascertain the equipment changes to implement them. The FAA has a detailed Enterprise Architecture, which shows the migration from the existing systems to the systems of the future. The architecture consists of several functional areas, including automation, communications, surveillance, navigation, and weather. These functions are supported by various types of computers, radios, broadcast stations, and sensors. By developing the architecture to show all the air traffic control systems and what functions they perform, engineers can determine the system upgrades and schedule for changes to implement new capabilities.

The Enterprise Architecture is partially portrayed on "roadmaps" that show the present and future configurations of air traffic control equipment. The roadmaps (discussed in section 4 below) show the planned evolution to the NextGen. They also show the planned schedule for either replacing or updating existing equipment. The architecture is the foundation for building a capital plan, and it allows work to be scheduled and coordinated so that everything is installed in the right place and at the right time when new capabilities are added.

Solution sets identify specific capabilities that will improve system capacity and efficiency. The sets are based on operational improvements that state how we will change our procedures to build system capacity through more efficient operations. Sections 3.1 through 3.7 describe the solution sets, including an initial assessment of the changes we will need to make in air traffic control systems as well as the associated investment required to implement those changes.

3.1 Initiate Trajectory Based Operations

Summary Description:

Trajectory-Based Operations (TBO) will improve efficiency of operations. Aircraft will be assigned to fly negotiated trajectories, which allows airspace to be used more efficiently because aircraft separation is preplanned and maintained as long as all aircraft stay within their planned trajectory and reach pre-assigned waypoints at the agreed time. Computer automation — ground and airborne — create these trajectories, and the trajectories are exchanged with aircraft by DataComm, a data link system that can automatically transmit data to and from FAA facilities. The aircraft position is reported by ADS-B, so the controller knows whether the aircraft has stayed within the trajectory and remains free of conflicts. Significantly more trajectories can be created then would be allowed by traditional route and altitude planning. Key elements in making TBO work is the rapid exchange of information that DataComm provides and FAA's ability to negotiate via DataComm with pilots on how to maneuver if they are outside their approved trajectory. This solution set focuses primarily on en route cruise operations, although all phases of flight will feel the effects of the TBO.

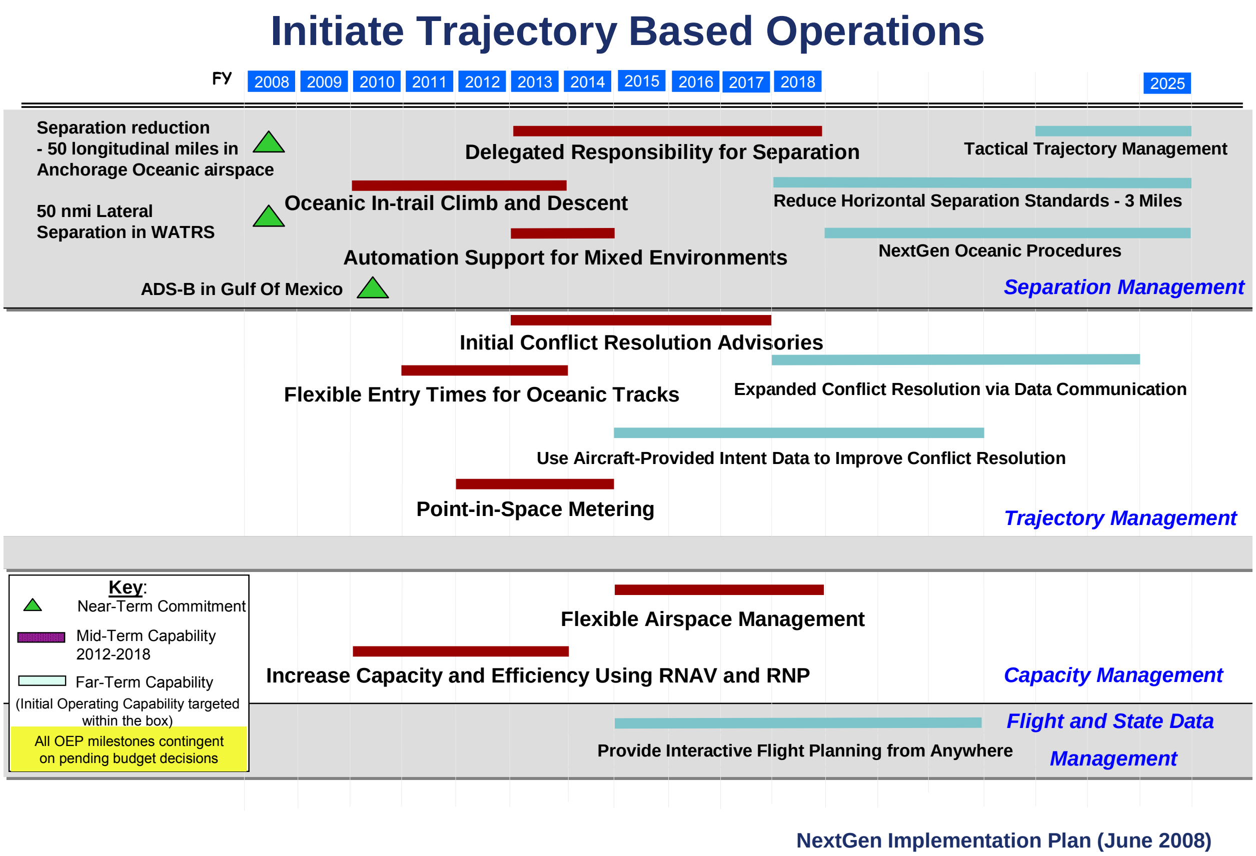
Background:

Voice communication is the primarily tool for managing flights in today's ATC system. Two-way radio is normally used to communicate clearances and changes in altitude and airspeed. Controllers separate aircraft by using radar screens to visualize future flight paths and identify potential conflicts with some automation decision support. With the diversity of aircraft operating characteristics and differing accuracy of their navigational systems, a single set of equipment-based separation procedures and standards is becoming increasingly inefficient and limits capacity.

Operational Capability Description:

Implementation of new TBO capabilities appears in the timeline below. The FAA will implement TBO in several phases. One initial focus will be in oceanic airspace. Due to limitations in surveillance and direct communication over the oceans, controllers use large separation standards to ensure safety. With improvements in aircraft position reports and more efficient communication channels, controllers can safely reduce aircraft separation for properly equipped aircraft. In addition, aircraft can fly more efficient flight profiles to enter oceanic airspace. The next step will be to introduce TBO into domestic airspace for those aircraft with the precision navigation capability and flight management systems that allow them to maintain an assigned trajectory.

Timeline:



Required Investment:

The near-term improvements in the *Separation Management* service on the diagram apply to domestic and oceanic flights. Due to previous equipment limitations, aircraft oceanic separation was maintained at 90–100 miles. With satellite communication links and Automatic Dependent Surveillance – Contract (ADS-C), it is possible to greatly decrease required separation and offer more efficient entry into oceanic airspace. The equipment required is Global Positioning System (GPS), ADS-C, satellite communication data link, and upgrades to the oceanic automation system called Advanced Technologies and Oceanic Procedures (ATOP). These technologies along with procedures and training will allow for aircraft-to-aircraft in-trail separation to be reduced to 50nm or less depending on the oceanic area and aircraft equipage. As the technology matures, it may be possible to allow aircraft to use Automatic Dependent Surveillance – Broadcast (ADS-B) and a cockpit display of traffic information (CDTI) to ensure that aircraft maintain separation while performing maneuvers with even lower separations. Domestically, separation management grows to support a variety of precision-navigation-based procedures and separations as well as the first aircraft-to-aircraft flight-deck-supported separation procedures.

The *Trajectory Management* service manages trajectories within flows to ensure that the objective of each flight is accommodated as much as possible while maintaining the overall capacity of flows across the en route airspace. This service requires the automated capability to initially create the trajectory and then track the aircraft flying the trajectory to verify that it reaches a designated point in space at the required time to stay within the boundaries of the trajectory. The En Route Automation Modernization (ERAM) program and extensions to Traffic Management Advisor (TMA) will provide the foundation for this capability. The starting point is the current TMA and implementation of Release 3 (R3) of the ERAM software. In 2011 (as the roadmaps show in section 4), work will begin on a post-ERAM R3 work package to further expand this capability to all airspace.

Capacity Management service involves providing the airspace structure and workforce to support flexible ATC services. Expansion of navigation support to allow full point-to-point operations using area navigation (RNAV) and increased precision in the navigational performance of the aircraft allows a more flexible structure of closely spaced air routes which can be developed to increase airspace capacity. The new modern voice switch and the enhanced flight data management of ERAM will also allow the airspace to be managed and assigned to controllers more flexibly, thus permitting controllers to more effectively guide aircraft around major storms. This ability to maintain greater levels of capacity in bad weather will reduce the need to restrict demand, as currently required in the Airspace Flow Program.

The final block on the TBO Capability diagram is *Flight and State Data Management*. Automation systems in different air traffic facilities share information continually as an aircraft flies across the country. We must update or replace existing systems to ensure information on all flights being followed is current and reflects changes in flight plans made before and during the flight.

3.2 Increase Arrivals and Departures at High Density Airports

Summary Description:

The solution set addresses improving use of available capacity at airports:

- With large numbers of operations;
- That have multiple runways with both airspace and taxiing interactions; and
- That are in close proximity to other airports that have the potential for airspace interference

Background:

For various reasons, it is difficult for an airport to achieve its maximum arrival or departure capacity. When the arrival stream contains small and large aircraft intermixed, larger separations are required. The cause can be differences in arrival speed or the effect wake turbulence from large aircraft can have on small aircraft following closely behind. Because of the effects of wake turbulence, controllers must increase separation between smaller aircraft which follow larger aircraft to 5 miles or more. Multiple runways can also complicate movement of aircraft on the ground and create restrictions on the number of takeoffs from available runways. In major metropolitan areas, multiple major hub airports must share airspace and capacity at these airports decreases when winds prevent use of runways with conflicting approach paths.

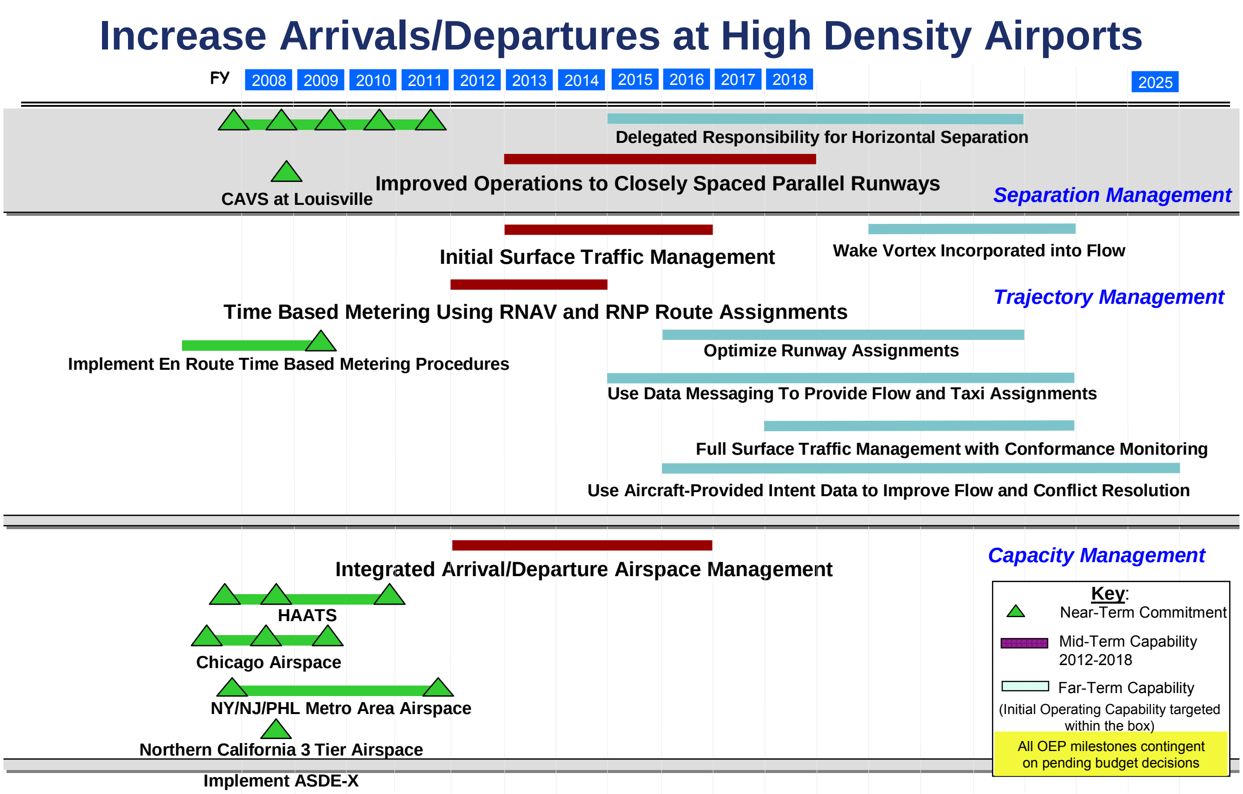
Operational Capability Description:

Better management of flows of aircraft landing at and departing from major airports will allow fuller use of runway capacity. Coordinating trajectory-based operations so that aircraft arrive in an optimal sequence will remove some of the existing inefficiencies in landing aircraft. Improved monitoring of aircraft, while taxiing, will decrease departure delays. Installing new technology will eliminate some current restrictions on approaching and departing aircraft.

Examples of solutions are:

- Using ground surveillance radars and surface management systems to help taxiing aircraft reach the runway sooner and in the right sequence to maximize the runway throughput;
- Allowing pilots to use a Cockpit Display of Traffic Information (CDTI) to maintain separation from other aircraft on final approach when arrival streams are relatively homogeneous;
- Using precision radar to allow simultaneous landings on closely spaced parallel runways; and
- Requiring pilots to arrive at a terminal fix at an assigned time so that the flow of aircraft can be arranged to minimize the greater separations needed between large and small aircraft.

Timeline:



NextGen Implementation Plan (June 2008)

Required Investment:
To support increases in arrival and departure rates at airports, we need more sophisticated automation, communication, and surveillance equipment. Terminal automation platform enhancements are necessary to support time-metered entry points for airport approaches. The DataComm system will allow rapid transfer of both data and air traffic control information to ensure that pilots follow the exact path planned and controllers maintain separation between arriving and departing aircraft. We will require the ADS-B system for rapid updates of aircraft position so that controllers are confident that aircraft are following their assigned path.

In the *Separation Management* area of the diagram above, Implementation of "Delegated Responsibility for Horizontal Separation" will require aircraft to equip with a CDTI and ADS-B technology. Any aircraft that maintains self-separation must have ADS-B (In) technology that allows that aircraft to receive information from other aircraft and ground stations giving the location of nearby aircraft. This information is then displayed on the receiving aircraft's CDTI, enabling its pilots to see the position of surrounding aircraft that are equipped with ADS-B (Out). ADS-B Out-equipped aircraft continuously broadcast their position obtained from onboard navigation equipment. The cockpit display in the receiving aircraft gives the precise distance to the aircraft being followed and also shows information on its speed and altitude. This display helps pilots maintain separation from a leading aircraft when controllers delegate responsibility for separation to them.

"Improved Operation to Closely Spaced Parallel Runways" is also possible for aircraft equipped with ADS-B and certified for Required Navigation Performance (RNP). The improved navigational performance and the potential use of ADS-B and CDTI, when required, give pilots sufficiently accurate information to maintain safe separation during simultaneous operations on these runways. These techniques will expand the throughput on existing and future parallel runways.

In the *Trajectory Management* area of the diagram, "Initial Surface Management and Time Based Metering" will depend on RNAV and RNP routes, the ASDE-X surveillance system, and terminal automation enhancements. The RNP and RNAV routes allow more efficient use of the airspace because aircraft have the equipment and crews have the training to maintain their intended route of flight within close tolerances. The aircraft and the aircrew are certified to be able to maintain the approach route with no more than a specified (for example 0.3 miles) deviation from that path. This reduces the potential for conflicts in approach paths for airports in close proximity. We need capital investment to create and test these RNAV routes, which are available to aircraft with the appropriate RNP rating. The rapid update radar will provide the controller frequent updates of an aircraft's position to ensure that it is following the assigned flight path. Time Base Metering, as mentioned, relies on Traffic Manager Advisor automation upgrades and helps manage the stream of arrival aircraft by assigning a specific time to reach the entry point to transition to terminal control.

The *Capacity Management* area depends on airspace redesign and terminal airspace consolidation to improve use of airspace surrounding an airport. Improvements in service stem from technology enhancements in surveillance that the ADS-B program provides. This system receives position information from aircraft and transmits it to control facilities. ADS-B is a key technology for two reasons. Distance from the ground station does not affect accuracy, and ADS-B updates position information more rapidly than conventional ground radars. Both capabilities support expanding use of terminal-area procedures that increases efficiency of arrivals and departures. Controllers will have timely and accurate information on whether aircraft are following their assigned trajectory in order to ensure that they are maintaining proper separation. At Chicago, New York, Houston, and other major airports, additional arrival and departure routes are being created, which will decrease airspace congestion and reduce the possibility of conflicts.

3.3 Increase Flexibility in the Terminal Environment

Summary Description:

This solution set concentrates on the improvements in the access, situational awareness, and separation services that all airports, from the largest to the smallest, may require. Unlike the high-density solution set that focuses on the increased traffic management to manage the high demand, this solution reflects the common needs that all airports have: precision landing, surface situational awareness, and improved management of flight data.

Background:

Flexible terminal operations serve a mix of Instrument Flight Rules (IFR)/Visual Flight Rules (VFR) traffic, with aircraft types ranging from airline transport to low-end general aviation. Airports can be towered or non-towered, depending on traffic demand. In the future, some satellite airports will experience higher traffic demand due to migration of less sophisticated aircraft to these smaller airports to mitigate traffic congestion. These airports can accommodate the potential increase in use of personal aircraft for pleasure and business and emergence of on-demand air taxi services using very light jets (VLJs).

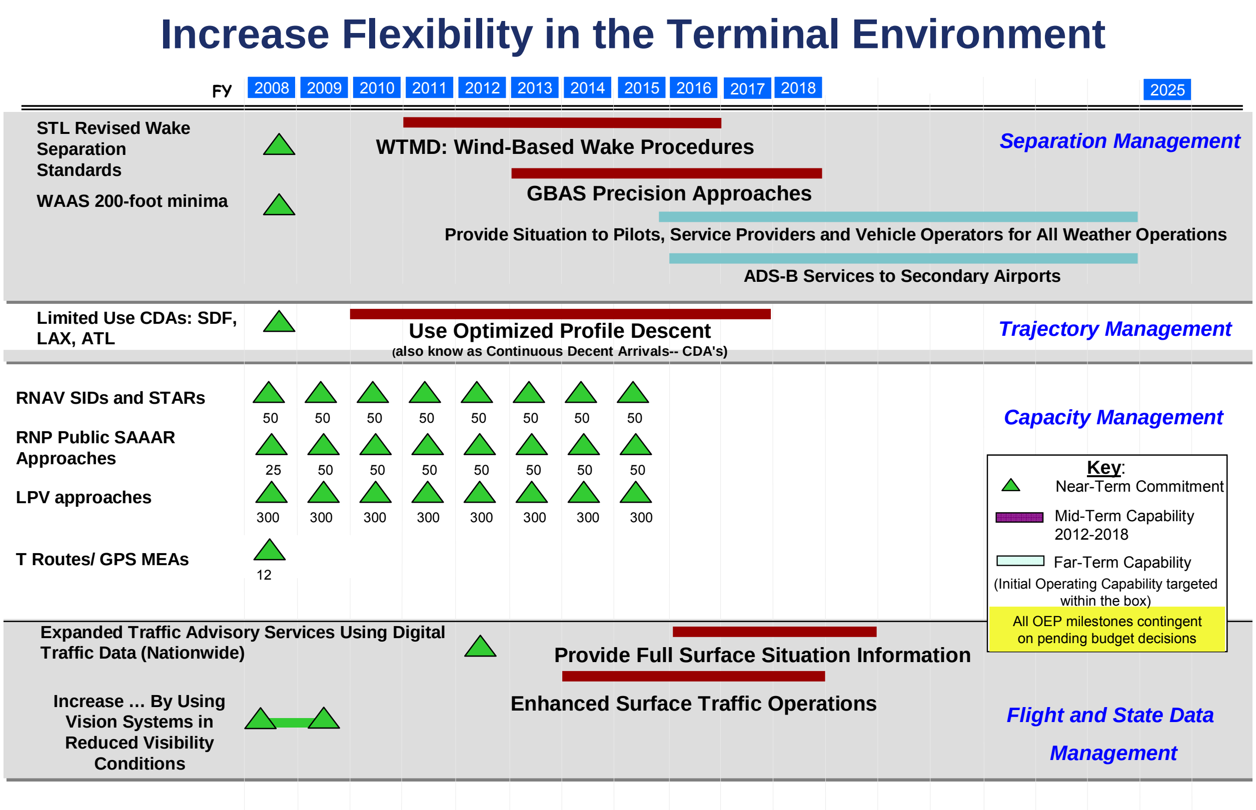
Operational Capability Description:

Operational Improvements focus on improving services at all airports in nearly all weather conditions without increasing staffing at those airports with staffed air traffic facilities. Planned elements include: developing “equivalent visual” approach procedures; providing support for low visibility taxi and departure operations; improving access to weather information; implementing improved wake vortex procedures; and developing procedures for the more efficient and environmentally sensitive optimal profile/continuous descent approaches. A major metric of this program will be increased capacity without a corresponding increase in human resources. Establishing a RNP-3D requirement and associated ground automation trajectory modeling will allow increased use of optimal profile descents without loss of capacity in higher traffic demand periods.

A Ground-Based Augmentation System (GBAS), also know as the Local Area Augmentation System (LAAS), will provide an optional lower cost alternative to the Instrument Landing System (ILS) for Category (CAT) II and CAT III-like approaches. The system could extend CAT II/III services to airports where a conventional ILS can not be installed due to siting constraints, assuming additional infrastructure (e.g., lighting) is economically justified. A ground-based augmentation system will also support a higher number of precision approaches at major airports by providing for precision missed approaches that avoid conflicts with other traffic near the airport. Finally, this system will enable offset landing thresholds for high-density airports, helping to implement wake-avoidance procedures on arrivals.

Cockpit displays of assigned taxi route, coupled with display of surface traffic and other hazards, enable aircraft to safely taxi at or near normal taxi speeds in low visibility and at night. Such improvements may virtually eliminate runway incursions and other taxi errors.

Timeline:



NextGen Implementation Plan (June 2008)

Required Investment:

The Wake Turbulence Mitigation for Departures (WTMD) system will mainly be installed at high-density airports with closely spaced parallel runways to eliminate the wake turbulence separation time presently used when a B757 or heavier aircraft is taking off on an adjacent runway. This separation time interval can be eliminated, if crosswinds are sufficient to keep the wake turbulence from the larger aircraft, out of the path of the aircraft on the parallel runway. Production of the WTMD system began in FY 2009, and funding is being requested for continued production and further testing.

For *Trajectory Management* and *Capacity Management*, Operations funding will generally cover development and testing of the following improvements, which will not require capital investment:

- Optimized Profile Descent (Continuous Descent Approach);
- Area Navigation (RNAV) Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs);
- Required Navigation Performance (RNP) Approaches;
- Lateral Precision with Vertical Guidance (LPV) Approaches; and
- T Routes (more efficient direct routes through terminal airspace).

Development of enhanced procedures and associated automation changes to implement these improvements will be a capital investment, with follow-on individual site adaptations funded in the Operations budget. The ability to use these new procedures will be supported by equipment in the aircraft and, for some procedures, the LAAS. When LAAS is tested and approved, it can provide new capabilities to smaller airports and possibly reduce the number of ILSs at high-density airports.

For *Flight and State Data Management*, several new capabilities are being planned to enhance surface traffic operations. This requires providing full surface situation information to pilots. Investments needed to support these capabilities are ADS-B, Airport Surface Detection Equipment (ASDE) Low Cost Ground Surveillance (LCGS), and appropriate displays and communication equipment. The Flight Information System can broadcast the location of other aircraft from ADS-B ground stations to properly equipped aircraft on the taxiways. DataComm can send other information, such as taxi routes to the pilot.

3.4 Improve Collaborative Air Traffic Management (CATM)

Summary Description:

This solution set covers strategic and tactical flow management, including interactions with operators to guide choices when FAA cannot accommodate the desired route of flight. Collaborative Air Traffic Management (CATM) includes flow programs and collaboration on procedures that will shift demand to alternate routings, altitudes, or times when there is severe weather affecting operators’ planned routes, or demand for certain routes exceeds capacity. CATM also includes development of systems to distribute and manage aeronautical information, manage airspace reservations, and manage flight information from preflight to post analysis.

Background:

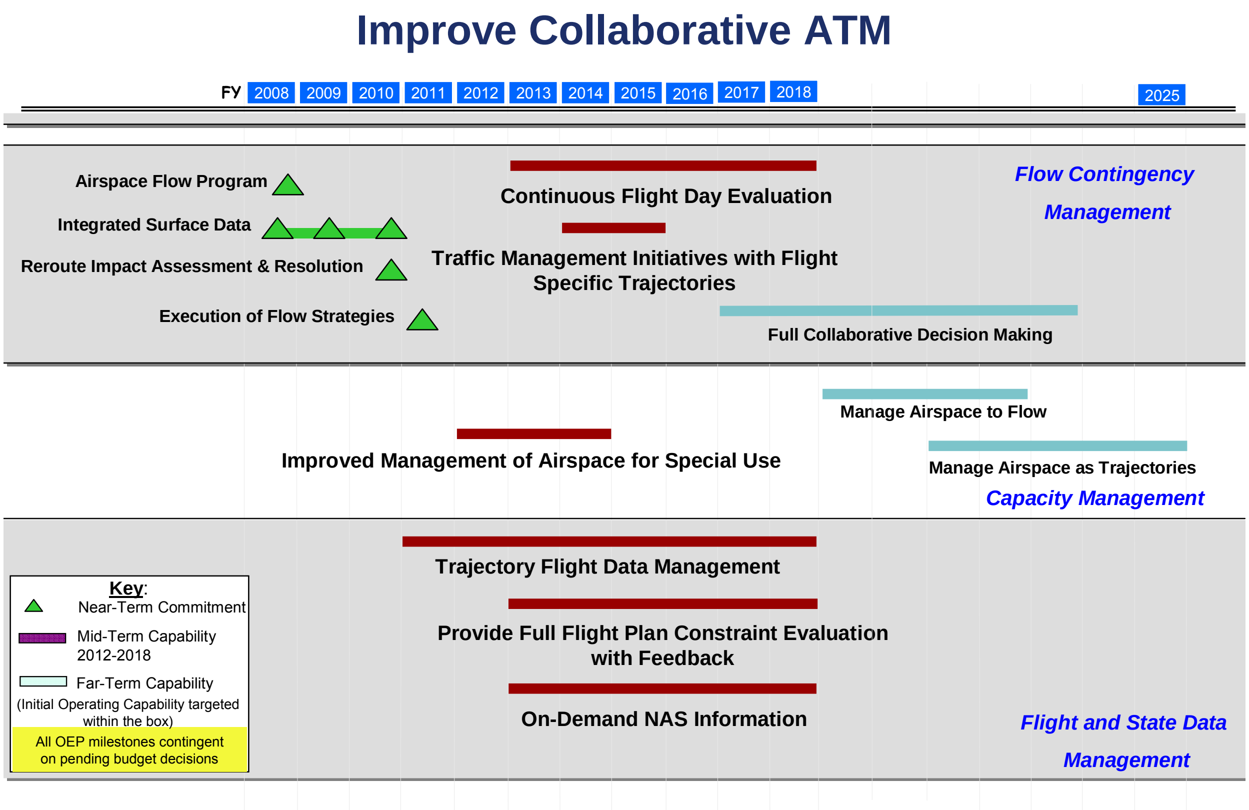
Current tools for managing Air Traffic Management (ATM) system demand and capacity imbalances are relatively coarse. Optimal solutions would minimize the extent to which flights are either over-constrained or under-constrained. Flight restrictions can unnecessarily interfere with optimizing operator efficiency and increase the cost of travel. Restrictions also inhibit operators from specifying a preferred alternative and constrain their involvement in resolving imbalance issues. The overall philosophy driving delivery of CATM services in the NextGen is to accommodate flight operator preferences to the maximum extent possible. Restrictions should be imposed only when a real operational need exists. If restrictions are required, the goal is to maximize opportunity for airspace operators to resolve them, based on their operational priorities.

Operational Capability Description:

The NextGen goal is for all airspace operators to be able to collaborate on ATM decisions. This information exchange will range from current large-scale flight operations centers with complete CATM automation tools to individual pilots with handheld personal computers. Individual pilots (personal users) will have appropriately scaled CATM collaboration access. To the extent possible, the affected air traffic control facility will make decisions fully aware of system wide NextGen implications. This will also include, to a greater extent than ever before, an increased level of decision-making by the flight crew and/or flight operations centers.

CATM will balance operator objectives and constraints with overall NAS performance objectives. To ensure that locally developed solutions do not conflict with overall goals or other implemented strategies, decision-makers will look to NAS-wide objectives and test solutions to identify interference and conflicts with other initiatives.

Timeline:



NextGen Implementation Plan (June 2008)

Required Investments:

"Continuous Flight Day Evaluation" will improve air traffic management by incorporating real-time information on operational constraints so that both FAA and users will be able to assess and readjust flight plans to take advantage of the most favorable routings. Current systems are incapable of rapidly updating information on constraints that affect the route of travel. Investments that support this capability include ERAM Release 3, Aeronautical Information Modernization (AIM) Segment 1, Collaborative Air Traffic Management Technologies (CATMT) Work Package 2, and the System Wide Information Management (SWIM) Segment 2.

The current automation systems do not support flight-specific assignment of trajectories for traffic flow purposes. The "Traffic Management Initiatives with Flight Specific Trajectories" will be capable of preparing these types of trajectories so that Command Center or center Traffic Management Units can offer the best routings to individual flights based on up-to-date information on the status of the NAS. This capability will depend on implementation of ERAM releases 2 and 3 and CATMT Work Package 2.

“Improved Management of Special Use Airspace” will upgrade the flow of information on the status of this airspace so that users have current data on when civilian flights can use this airspace. Large blocks of airspace are reserved for military operations and other special uses. When portions of this airspace are not in active use and proper coordination is completed, civil aircraft may have access to this airspace. Opportunities to use this airspace are currently inhibited by limitations on sharing this information. This improvement will depend on implementing Aeronautical Information Management (AIM) Modernization Segment 1.

“Trajectory Flight Data Management” will provide current flight data, including aircraft location information that all air traffic facilities and authorized users can access. Current systems cannot provide the flexibility for every facility to alter a trajectory when circumstances change and a rerouting is required. This system will allow continuous monitoring of air traffic and allow more rapid and efficient rescheduling of trajectory-cleared routes as needed. In addition to ERAM, AIM, and CATMT improvements, this capability requires developing requirements for Flight Object data systems.

“Full Flight Plan Constraint Evaluation” will inform pilots of any expected limitations on their planned route of flight as they file their flight plans. This information will be up to date so that pilots will not have to plan for a less-than-optimal route to accommodate constraints that are no longer in effect. Current systems use planning data instead of actual data, and upgrading to dynamic data collection will improve efficiency of flight and adjustment of workforce. This capability will require AIM, CATMT Work Package 2, and the ERAM mid-term work package.

“On-Demand NAS Information” will be available to all users who are equipped to receive it and who request it. This will assist pilots in flight planning and allow them to monitor weather and traffic conditions when they are airborne. This will allow for more efficient planning and accelerate the process for changing routes when unpredicted weather requires a diversion. This capability requires ERAM Release 3, SWIM, and AIM.

3.5 Reduce Weather Impact:

Summary Description:

Reduce Weather Impact (RWI) is a planning and development portfolio to ensure NextGen operational systems take advantage of a broad range of weather detection and forecast improvements and technologies to mitigate the effects of weather in future NAS operations. This portfolio has two major elements: weather observation improvements and weather forecast improvements. These elements combined will provide improved, consistent weather information that can be integrated into air traffic decision support tools that will enable more effective and timely decision making by both Air Navigation Service Providers (ANSP) and users. These improvements will support meeting future capacity, efficiency and safety objectives. They enable FAA and users to share a common understanding of the forecast of future atmospheric conditions, and they support traffic flow management for trajectory based operations and provide for improved weather avoidance.

Weather plays a significant role in all NAS operations. RWI is one of several complementary and interrelated weather investments that will build integrated capabilities for the future. RWI will address improvements in weather observation quality and facilitate integrating weather forecasts into user decision support tools. Advanced weather forecast research is conducted under the Aviation Weather Research Program (AWRP), and RWI will transition these AWRP efforts into operational use. The NextGen Network-Enabled Weather (NNEW) transformational program will provide universal common access to weather information through the 4D Weather Data Cube. Weather Technology in the Cockpit (WTIC) research program will develop weather improvements suitable for in-flight operational decision making. Collectively the projects in the NextGen portfolio will result in weather information being integrated with, and supporting NextGen decision-oriented automation capabilities and human decision-making processes, rather than just being displayed, which requires cognitive interpretation and impact assessment, which limits the ability to significantly impact delays.

Background:

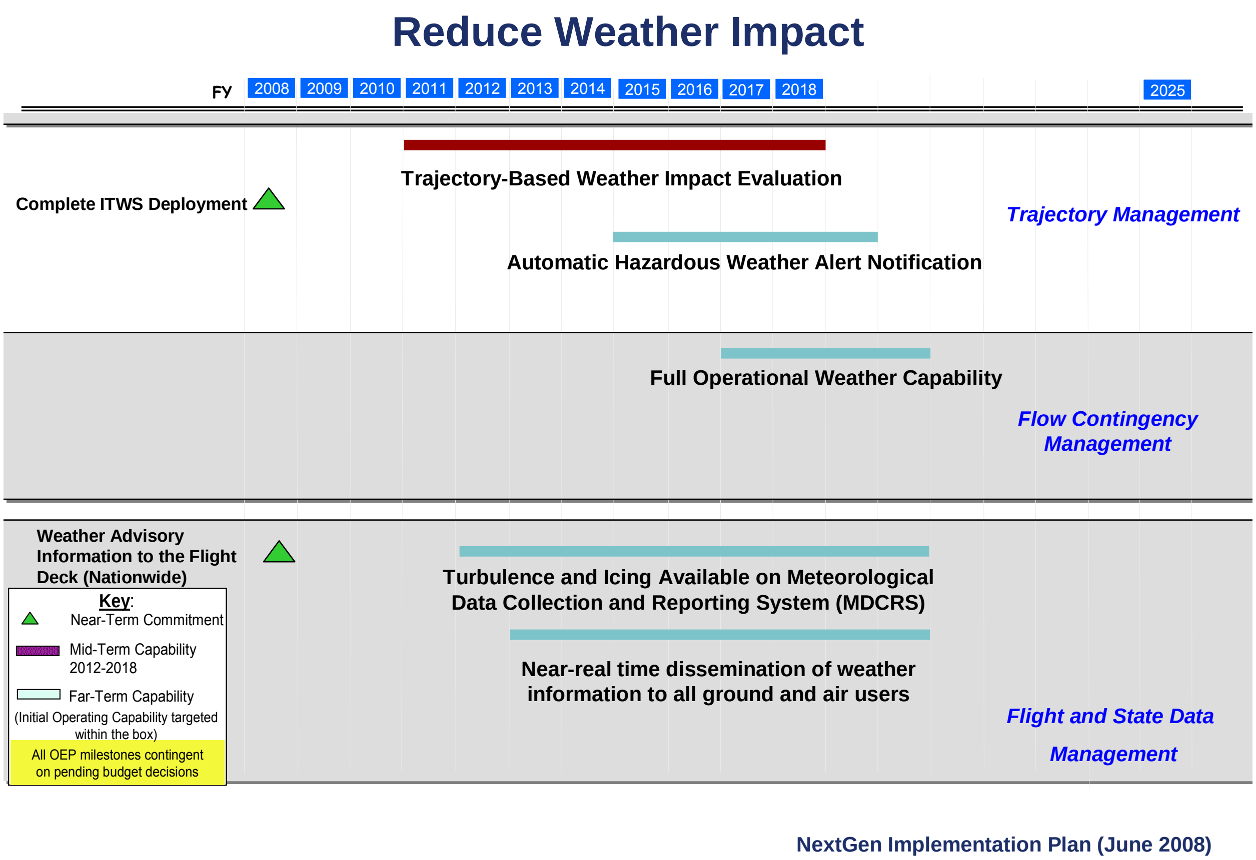
In today's NAS, weather is responsible for 70% of delays over 15 minutes and contributes to 24% of accidents and 34% of fatalities. Estimates have been made that up to two-thirds of weather delays are avoidable. Despite a continuous flow of improvements aimed at providing better weather information, the significant impact of weather on aviation remains. Weather is the most significant factor causing delays and impacts safety of NAS operations. Impacts on aviation operations will increase as air traffic levels grow in the NextGen era.

Weather information is needed for aviation decisions, which range from planning individual flights to the management of airspace at individual terminals and management of overall NAS capacity. Collaboration among the ANSP and users is required to mitigate the constraints resulting from adverse weather. Today, Air Traffic Management (ATM) units, airline Flight Operations Centers (FOC) and flight deck operational decision makers' collaboration on weather is somewhat ineffective because weather information today doesn't meet users' needs for every strategic and tactical decision. The current procedures for making these decisions are labor intensive, and rely on multiple weather inputs to obtain the required decision. The system is not optimized to support decision makers and it has gaps in both weather observation and dissemination of current weather conditions and forecasts, as well as deficiencies in those forecasts regarding their accuracy and consistency with other forecasts.

Operational Capability Description:

Advances in weather information content and dissemination will provide users and/or their automated decision support systems with the ability to better predict specific weather impacts for individual airframes on planned operations (e.g., trajectory based operations and arrival/departure planning). Users will have access to weather information that helps them assess when re-planning or re-routing actions are needed. This customized weather information will be integrated into tactical and strategic decision support tools developed under the TBO, CATM, Flexible Terminal, and High Density Terminal solution sets. These tools will assess the risk for weather impacts on flights/trajectories, and provide candidate actions to the ANSP that mitigate impacts on safety and traffic flow.

Timeline:



Required Investment:

Most improvements to reduce weather impact are mid and long term. The capabilities on the chart above build the weather infrastructure needed for improvements such as trajectory-based operations. As the NAS shifts towards management by trajectories, there will be a high reliance on weather data to improve path and time predictions in the determination of an actual trajectory agreement that accounts for traffic congestion and weather. In addition, operators and the air traffic controllers will need accurate predictions of the impact of weather on the currently planned trajectories to negotiate reroutes if adverse weather conditions arise after the flight is launched. To support trajectory-based operations, we will need to implement NextGen Network Enabled Weather (NNEW), the Next Generation Weather Processor, System-Wide Information Management (SWIM), and ERAM Release 3.

"Reduce Weather Impact" specific investments will assess the shortcomings of existing weather sensors, develop better sensors, and expand the sources of weather data. There will also be significant investments in new forecast algorithms to predict turbulence and icing conditions more precisely. Implementing trajectory-based operations will require more specific weather forecasts in real time. Investments in the NextGen Network Enabled Weather (NNEW) and the

NextGen Weather Processor will result in better sharing of weather information and more accurate, timely and tailored forecasts.

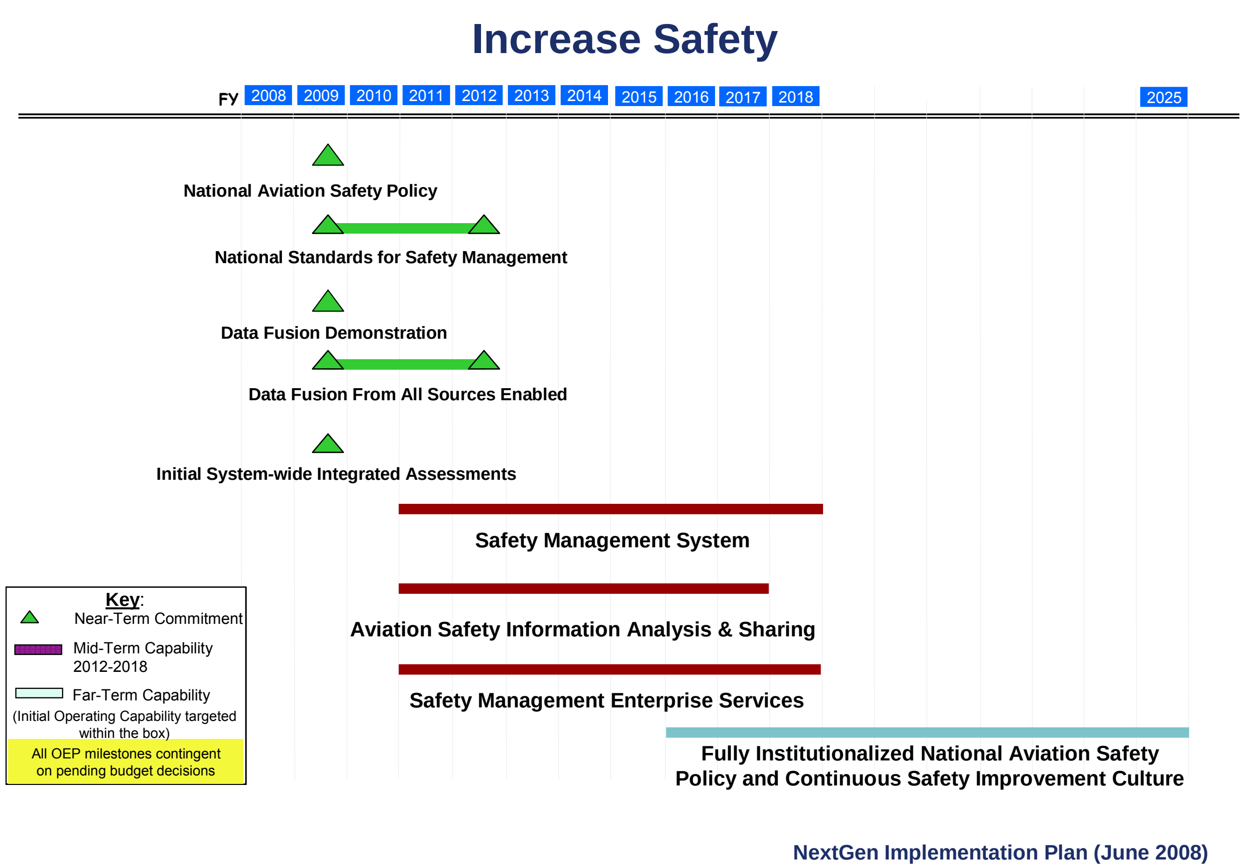
3.6 Increase Safety, Security, and Environmental Performance

Safety:

Summary Description:

Safety is FAA's highest priority. NextGen will emphasize integrating safety into the design and development phases. There are many operational programs in the FAA that address improving current safety performance. Since NextGen will be implementing new systems, the FAA has the opportunity to identify risks before installing them. This is consistent with the philosophy of the Safety Management System, which is used to carefully review both new equipment and the procedures to ensure that we have identified the safety risks and taken steps to eliminate them. We will interweave safety analysis with every initiative that is part of the NextGen effort.

Safety Timeline:



Required Investment:

To successfully implement the NextGen improvements, we must use a consistent and proactive safety management approach that incorporates advanced prognostic methods to forecast safety risk potential and encourages information sharing without fear of retribution. The *Safety Management System* creates a disciplined approach to understanding risk and developing systems that minimize that risk. We will analyze risk and design all the new systems to eliminate identified safety problems.

The *Aviation Safety and Information Analysis and Sharing* (ASIAS) system will integrate and share high-quality, relevant, and timely aviation safety information that is critical to the operational success of the Safety Management System. We are demonstrating data fusion from other safety databases in 2009 to support ASIAS, which should be fully operational in 2012. Implementing ASIAS will improve our ability to identify future safety risk, conduct a causal analysis of those risks, and recommend solutions for the commercial aviation sector. By developing new analytical techniques and leveraging state-of-the-art information technology, the FAA and its industry partners will be able to monitor effectiveness of safety enhancements by establishing baselines and examining trends for safety metrics to identify emerging risks.

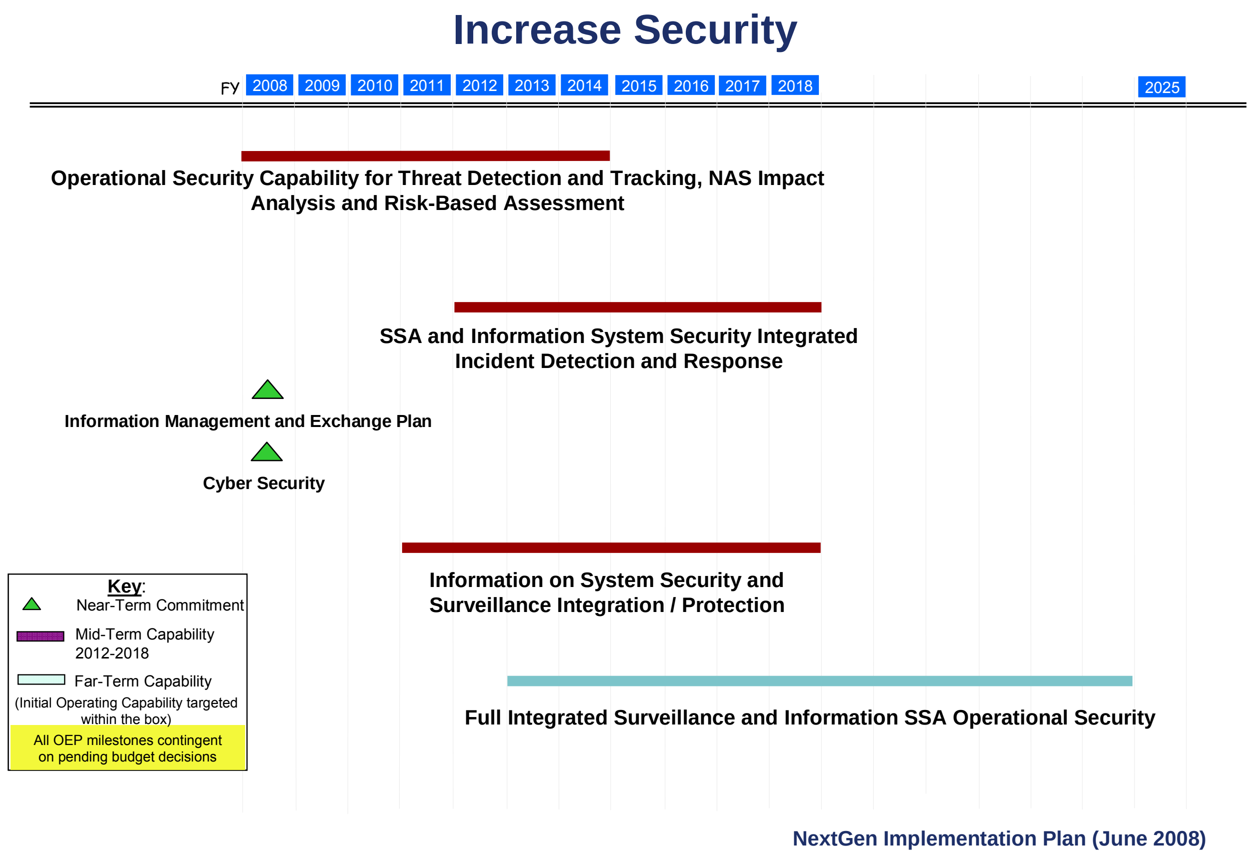
Safety Management Enterprise Services will provide the ability to evaluate the performance of individual systems and their impact on overall system risk. The combination of individual assessments and integrated analysis will support the goals of the Safety Management System.

Security:

Summary Description:

Security is necessary for all aspects of NAS operations. The FAA has planned investments in both airspace and information security. Airspace security deals with protecting air traffic control, communication, and navigation facilities. Information security is already integral to the baseline of each NAS program, and we have designed information security processes and protocols into new equipment to protect FAA systems. The FAA will provide continuous upgrades as information security technology and best practices improve. The agency also must be part of the national response and recovery for events, such as natural disasters (e.g., hurricanes) and preparation for biological events (e.g., pandemic influenza).

Security Timeline:



Required Investment:

The *Operational Security Capability for Threat Detection and Tracking, NAS Impact Analysis and Risk-Based Assessment* initiative integrates information on flight-specific risk levels provided by the Department of Homeland Security and trajectory-based assessment algorithms in FAA equipment. Monitoring flights and identifying security concerns early are essential for success in preventing terrorist actions.

The Security Integrated Tool Set (SITS) shown in the roadmap in the section 4.1 will enable the System Operations Security organization to perform data correlation, NAS impact analysis of security and/or emergency actions, as well as trend analysis. SITS will also support restricted airspace development and methods for sharing that airspace when it is not in use. We will seamlessly integrate these capabilities with Air Traffic Management systems and support defense, homeland security/disaster recovery, and law enforcement operations.

The *Shared Situational Awareness (SSA) and Information Security Integrated Incident Detection and Response* initiative is a cooperative effort among the FAA and other agencies to detect and correlate attempted information system intrusions so that the agencies can take actions to prevent them. We and other agencies have intrusion detection systems and Cyber Security Response

Centers that rely on timely reporting and cooperative efforts to identify and defeat attempted intrusions.

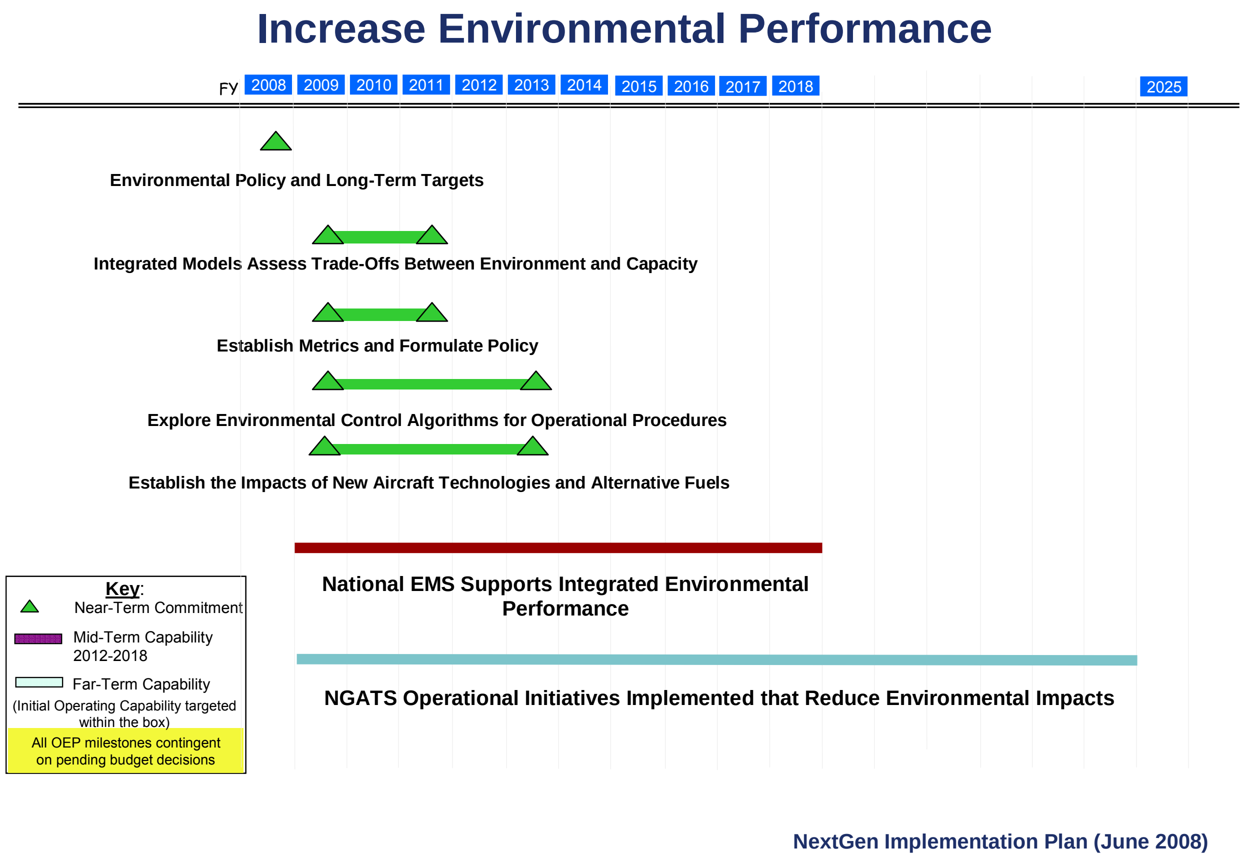
The *Information on Systems Security and Surveillance Integration/Protection* program processes and integrates surveillance information, which enables us to construct effective defenses to prevent disruptions of agency information systems.

Environment:

Summary Description:

Increased attention is being directed at aviation's impact on the environment — not only regarding longstanding noise and air quality impacts, but also in the important new areas of global climate change and energy consumption. Although aviation has been a relatively small source of emissions and has made significant strides in lessening its environmental "footprint," the anticipated growth in air transportation demand will increase pressure on aviation to reduce emissions and fuel consumption. NextGen investment planning must factor in changes in fuel use, emissions, and noise caused by operational improvements — both positive and negative. Fuel consumption is also a concern because of the long-term outlook for fuel prices. The FAA must carefully examine the environmental consequences of its actions and strive for improvements.

Environmental Timeline:



Required Investment:

Several efforts are already underway, as the first five lines on the chart above show. Although operating funds support many of these efforts, we will require continued capital investment to develop environmental policy, build models, establish metrics, and construct algorithms to determine the impacts of new aircraft technologies, aviation alternative fuels, and air traffic control procedures.

To achieve NextGen, we must proactively address environmental and energy impacts of the solution sets by integrating environmental protection objectives and requirements into core and business and operational strategies. A comprehensive Environmental Management System framework will provide the foundation and facilitate identifying environmental aspects and impacts of new operational procedures and help formulate and implement targets and plans to achieve environmental improvements.

3.7 Transform Facilities

Summary Description:

NextGen redesigns air traffic control systems to make them flexible, scalable, and maintainable. It breaks down the geographical boundaries that characterize air traffic control and leads to a more seamless view of traffic, organized not by geographically oriented sectors, but by aircraft trajectories. Infrastructure, automation, equipage, procedures, and regulations will be designed to support this seamless operational concept and must evolve from a geographical focus to a broader air traffic management concept. This includes facilities and the personnel who staff them.

To address this, the Facilities component of NextGen focuses on optimization of air navigation service provider (ANSP) resources. This includes the establishment and decommissioning of facilities, changes to the numbers and sizes of control facilities, and thinning/eliminating other facilities such as navigational aids. It also includes the allocation of staffing and facilities to provide expanded services; service continuity; best deployment, management, and training of the workforce; and the use of more cost-effective and flexible systems for information sharing and back-up.

Because of the net-centric capabilities and the geo-independence that NextGen provides, facilities do not require proximity to the air traffic being managed. Facilities will be sited and occupied to provide for air traffic management facility optimization. This includes combining facilities (e.g., air route traffic control centers (ARTCCs), terminal radar approach control (TRACONs), and air traffic control towers (ATCTs) towers when appropriate.

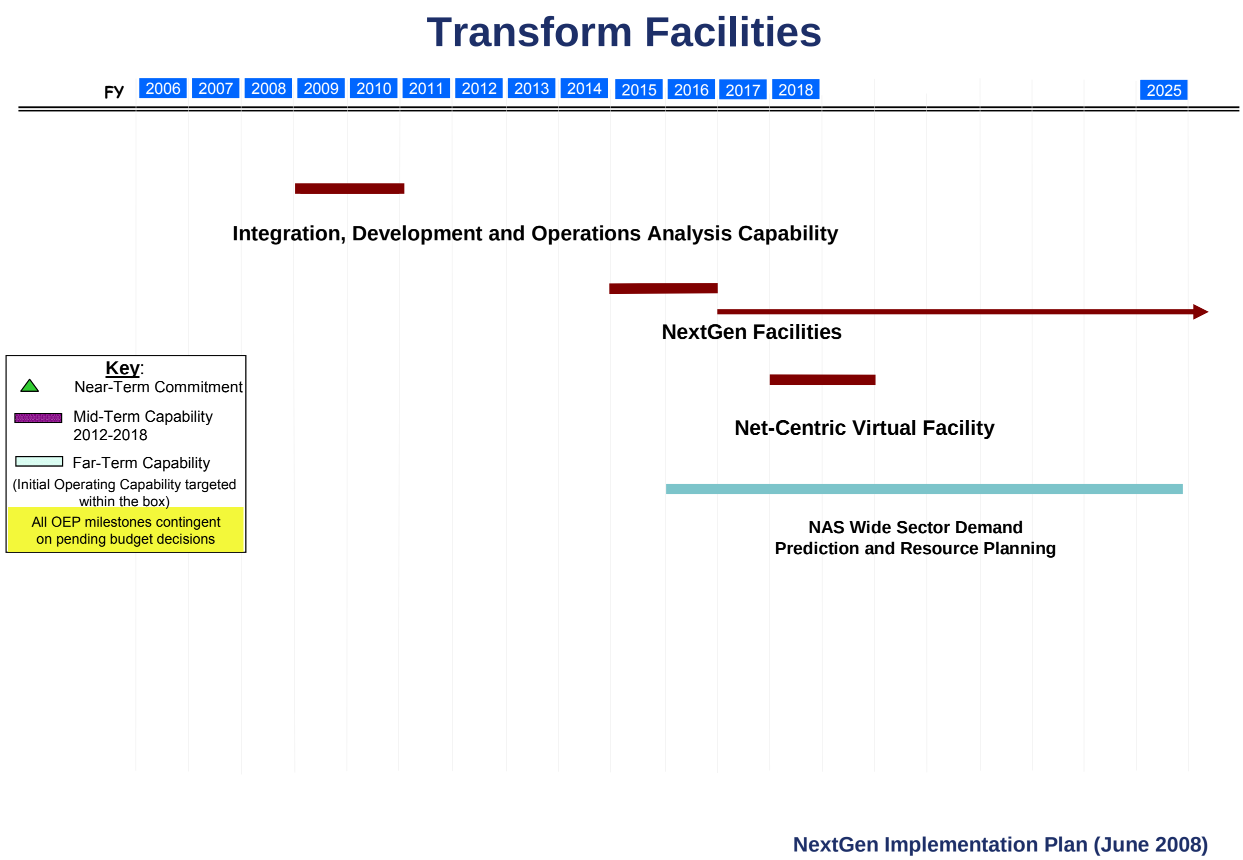
Background:

Today's air traffic system was built around 1960's radar technology and is constrained by its limitations. This geo-dependent model (communication constraints, hardware/software limitations, and available data distribution capabilities) dictated how many facilities were needed and their location. As a result of these limitations, the number of terminal and en route air traffic control facilities has grown to over 500. Security concerns, including location-based risks, distributed infrastructure constrained by legacy architecture, and disparate automation platforms, further challenge the air traffic control infrastructure. This results in operational inefficiencies, including capacity limitations and less than optimal business continuity planning (BCP) strategies. In addition, many of these facilities have aged to the point where repair and remediation is not cost effective.

To facilitate NextGen, handling increased traffic in the future while managing costs, improving and expanding services, and transforming FAA en route and terminal facilities to facilitate NextGen operational improvements is necessary. The current system has built-in limitations in flexibility, cost of service delivery, and continuity of operations. Some smaller airports have limited service due to its cost; creating a need to determine how to provide service in these locations, while reducing costs. Air traffic management facility optimization is needed to fully realize NextGen benefits.

Flexible infrastructure service delivery is needed to meet changing user needs and cost-effectively scale services up and down as needs change. This will ensure that the service providers and the information (e.g., flight data, surveillance, weather) are readily available when and where needed.

Timeline:



Required Investment:

Investment analysis regarding facility infrastructure will help frame the decisions concerning how to transform facility infrastructure to best accommodate NextGen capabilities. After the analysis is complete, funds will be requested to transform aging facilities into NextGen Facilities. Initial plans show a segmented implementation of NextGen Facilities and whether sets of facilities will be renovated, rebuilt or reconfigured.

Additionally, FAA plans to research and develop a Net-Centric Virtual Facility and convert some towers to this type of operation. A Net-Centric Virtual facility will depend on sensors at the airport to provide controllers at remote locations sufficient information to control traffic.

4 Enterprise Architecture Roadmaps

The detailed roadmaps appearing in the following sections are an integral part of the NAS Enterprise Architecture. The roadmaps show progression from the present system to NextGen. The roadmaps extend planning beyond the 5-year financial horizon covered in the CIP, and the transition to NextGen will be an incremental process over several years. Transforming the NAS to NextGen will require detailed engineering design to support new capabilities, and integration of operational changes that we must demonstrate and test. Some NextGen improvements will not receive funding until after the 5-year timeframe of the CIP, but projects that are foundational technologies for NextGen will have substantial funding during the next 5 years.

We update the roadmaps frequently to reflect the results of studies, demonstration projects, and economic analysis related to projects. Because of that, we do not attempt to explain all roadmap details. The purpose of including the roadmaps in the CIP is to show the full scope of long-term planning for system modernization. The funding tables at the end of each roadmap section contain both projects that are shown in the roadmap and those projects that are included in an overall FAA Enterprise Architecture which includes some projects that are not directly related to air traffic control. All projects with estimated funding over the next five years except very small and labor related projects are described in Appendix B. For more detailed information on the roadmaps, view the Enterprise Architecture and Roadmaps at:
http://www.nas-architecture.faa.gov.

Figure 4 defines the roadmap symbols. The dashed lines indicate that a system may be eliminated after economic and operational analysis is complete. The solid lines indicate either the continued operation of an existing system or the progression from a current system to a more capable or modernized system. The boxes with names identify systems, which are either described in the text or are the acronym is spelled out in appendix E with the systems' full name.

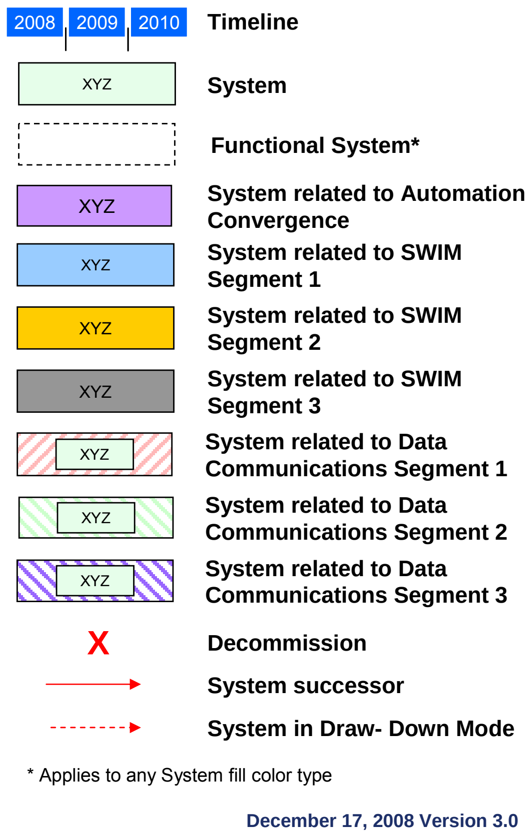


Figure 4 Roadmap Legend

4.1 Automation Roadmap

Automation is a core element of the air traffic control system. Controllers require a real-time display of aircraft location as well as information about the operating characteristics of aircraft they are tracking — such as speed and altitude — to keep the approximately 50,000 flights safely separated every day. Automation gives controllers continuously updated displays of aircraft position, identification, speed, and altitude as well as whether the aircraft is level, climbing, or descending. Automation systems can also continue to show an aircraft's track when there is a temporary loss of surveillance information. It does this by calculating an aircraft's ground speed and then uses the ground speed to project its future position.

Other important features of automation include the following:

- It maintains flight information and controller-in-charge data from pre-flight to post-flight analysis, which supports coordination between air traffic controllers as they hand off responsibility of the flight from tower to terminal to en route sector.
- It generates symbols displaying information on routes, restricted areas, and several other fixed features of the controller's sector.
- It uses software that further enhances safety by providing automated alerts to controllers regarding potential aircraft conflicts and warnings that an aircraft may be approaching a terrain hazard.

- It supports many functions that are essential to controlling air traffic, such as showing the data from weather sensors, giving the status of runway lights and navigational aids, and providing flight plan information on monitored aircraft.

The automation roadmaps in figures 5 and 6 depict the planned architecture from 2008 to 2025. The FAA will upgrade and ultimately replace current systems with more capable systems that can manage the levels of air traffic we predict for the future. These newer systems and the enhanced software will allow controllers to use airspace more efficiently and offer more sophisticated services, such as early approval of direct routes. They will also allow better allocation of workload among facilities.

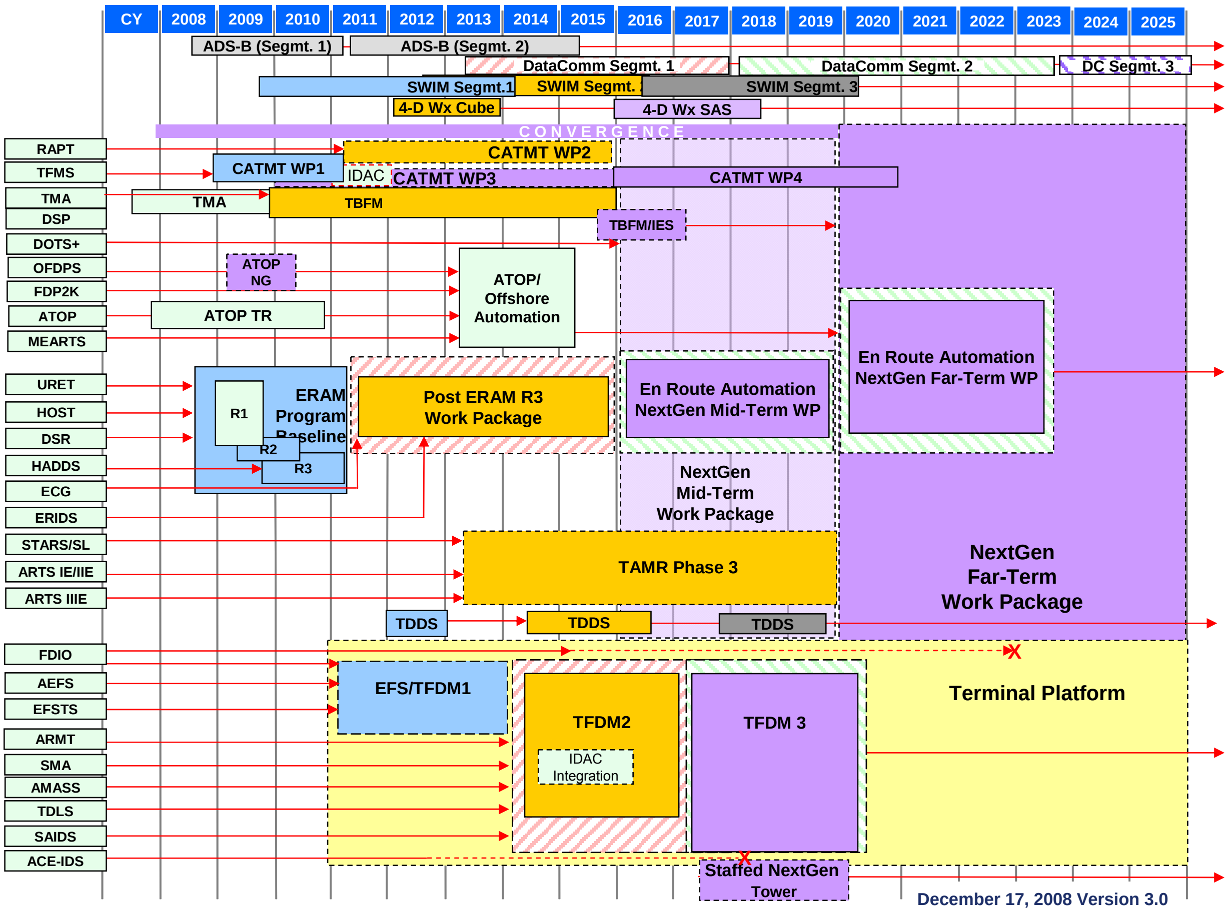


Figure 5 Automation Roadmap (1 of 2)

Enabling technologies for NextGen appear at the top of the automation roadmaps: System-Wide Information Management (SWIM), Data Communications (DataComm), Automatic Dependent Surveillance-Broadcast (ADS-B), and 4D Weather (Wx) Cube systems are central to collecting and sharing information used throughout the NAS. They transmit and receive critical information to support air traffic control in both the en route and terminal environments. When the 4D Weather Cube is fully developed it will be the Single Authoritative Source (SAS) for weather data, so the same data is available to both FAA and users to assist in making decisions. Collecting and sharing data is essential to improving NAS efficiency because it provides common ground for all parties participating in making the decision.

The first grouping on the left side of the roadmap contains the systems used for traffic management, such as Traffic Flow Management System (TFMS) and Traffic Management Advisor (TMA). The systems are installed at the Air Traffic Control System Command Center (ATCSCC), en route centers, and busy terminal control facilities. They are used to analyze future demand for en route and terminal services and strategically plan for how to best accommodate that demand. They use real-time displays of aircraft in flight and weather affecting aviation to assess which routes are best and to prevent severe congestion at airports. These functions will continue and be improved as described in the Collaborative Air Traffic Management (CATM) NextGen solution set, with expansion of collaboration to individual pilots and improvements in the information exchanged between the FAA and airline dispatch offices.

The next grouping on the left side is the oceanic control projects. They are the automation systems (OFDPS, MEARTS, FDP2K, and ATOP) that process data regarding the position of oceanic flights to aid controllers in separating flights that the FAA controls in the oceanic areas. The DOTS+ system uses weather information to determine the most fuel-efficient routes based on wind velocity and direction. The FAA will consolidate all of these systems into the Advanced Technology Oceanic Procedures (ATOP) system when ATOP receives a technology refresh; and the FAA plans to decide in 2015 whether to continue ATOP after that time or fold its functionality into the NextGen Mid-Term Work Package.

The next six blocks on the left side are components of the en route control system, which the FAA is replacing with the En Route Automation Modernization (ERAM) program. ERAM replaces hardware and rewrites the ATC software used at en route centers. ERAM is being tested at the first operational site, and it is scheduled to be operational at all en route control centers by 2011. Its initial purpose is to modernize ATC automation systems and expand capacity. After that has been done, the later releases of the ERAM software are necessary to initiate Trajectory Based Operations. As the roadmap shows, the FAA will transform ERAM over time into a NextGen Automation System that will address both en route and terminal automation requirements.

The next three systems (STARS/S L, ARTS 1E/IIE, and ARTS IIIE) are different terminal automation models that the FAA will sustain as separate systems, and the Terminal Automation Modernization and Replacement Phase 3 (TAMR P3) program will replace and modernize STARS and/or ARTS systems until the agency eventually consolidates them as part of the NextGen Work Package.

Tower Flight Data Manager (TFDM) will be a phased implementation of a new Terminal local area network (LAN)-based infrastructure targeting reduction of redundancies, integration of flight data functions, and providing System Wide Information Management (SWIM) enabled flight data exchanges with other National Airspace System (NAS) subsystems. TFDM Phase 1 is the initial capability that will integrate Flight Data Input/Output (FDIO), Advanced Electronic Flight Strip (AEFS) and Electronic Flight Strip Transfer System (EFSTS), while TFDM phase 2 will integrate the Airport Resource Management Tool (ARMT) and the Tower Data Link Services (TDLS) function. Trade studies will identify if additional elements will be integrated, such as Departure Spacing Processor/Departure Flow Management (DSP/DFM), Automated

Surface Observing System (ASOS) Controller Equipment-Information Display System (ACE-IDS), and System Atlanta Information Display System (SAIDS).

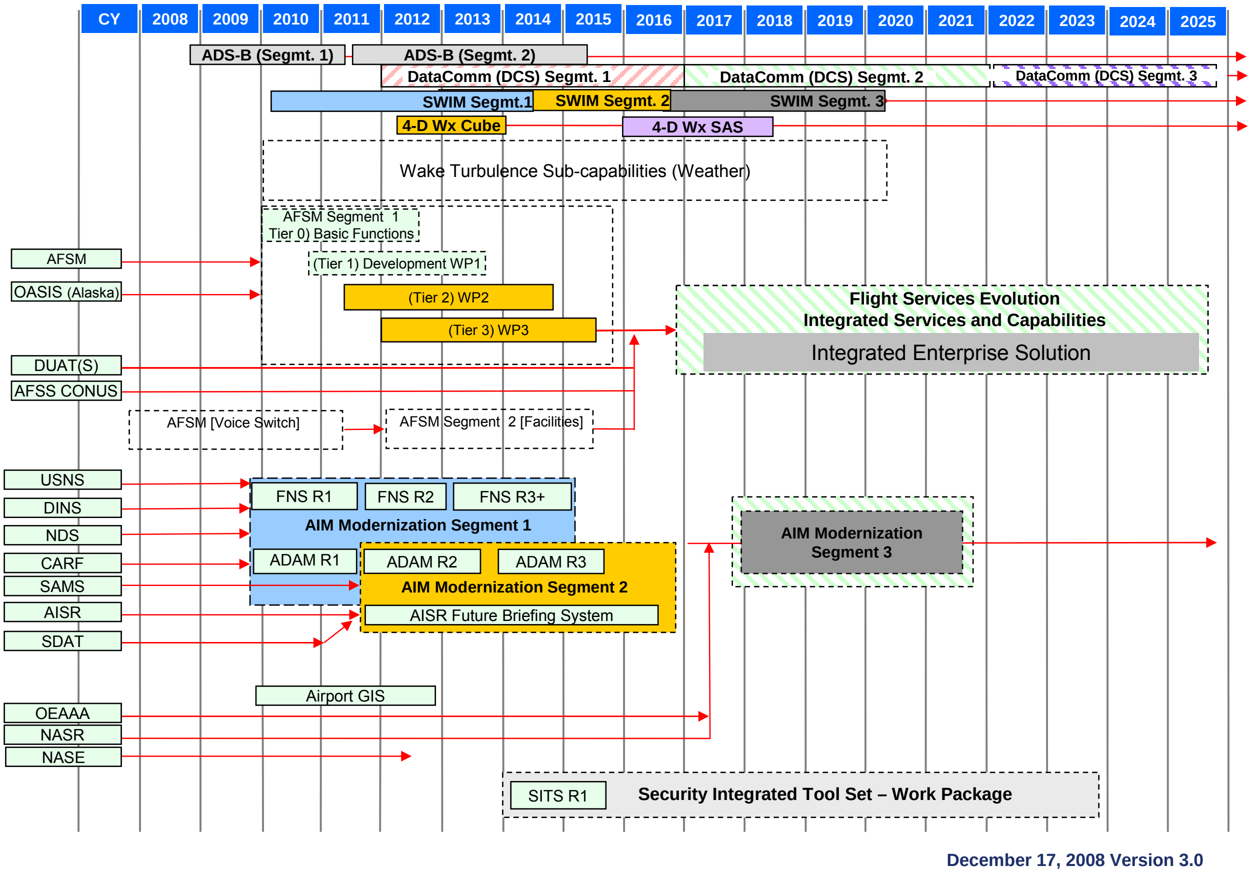


Figure 6 Automation Roadmap (2 of 2)

AFSM, OASIS (Alaska), DUATS, and AFSS CONUS on the top left side of Figure 6 support flight services. Flight services are generally used by individual pilots and include weather briefings and filing of flight plans. The FAA has contracted for flight services in the lower 48 states, and the contractor is responsible for upgrading equipment, such as flight service specialist workstations. The Direct User Access Terminals (DUATS) currently allow pilots to file flight plans and obtain weather information for their planned routes from flight service station automation systems. Flight service specialists use Flight Service Automation Systems (AFSS CONUS and OASIS (Operational and Supportability Implementation System) to record flight plans and provide weather briefings to pilots. The Alaska Flight Service Modernization (AFSM) project will replace the existing automation systems used in FAA-operated flight service stations. We will also request funding to upgrade the buildings and supporting equipment for Alaska's flight service stations.

The next 10 systems (USNS, DINS, NDS, CARF, SAMS, AISR, SDAT, OEAAA, NASR, and NASE) mainly provide status information on airports, airspace, and navigation facilities, but the

FAA uses some of them to evaluate airspace. A modernized and consolidated Aeronautical Information Management (AIM) system will replace these individual systems.

- USNS — United States NOTAM (Notice to Airmen) System,
- DINS — Defense Internet NOTAM Service,
- NDS — NOTAM Distribution System,
- CARF — Central Altitude Reservation Function,
- SAMS — Special Airspace Management System,
- AISR — Aeronautical Information System Replacement,
- SDAT — Sector Design and Analysis Tool,
- OEAAA — Obstruction Evaluation/Airport Airspace Analysis,
- NASR — National Airspace System Resources,
- NASE — NAS Adaptation Services Environment.

NOTAMs are notices of temporary changes, such as temporary flight restrictions and runway closures for construction. SAMS and CARF inform controllers when airspace ordinarily reserved for military use is available for civilian use. The other systems contain more detailed information about FAA air traffic control equipment or less frequently changed information such as charts and airspace regulations. The AIM program will establish a standard format and a user-friendly interface for finding the information related to a specific route of flight.

The Security Integrated Tool Set (SITS) is a security system that validates the identity and legitimacy of aircraft within or entering the NAS; it will be incorporated into the NAS in 2014.

Figure 7 shows projected CIP expenditures on automation roadmap projects.

BLI Number	Program Name	FY 2010 Budget	FY 2011	FY 2012	FY 2013	FY 2014
	Automation Functional Area	**$715.4**	**$741.8**	**$764.9**	**$715.0**	**$678.3**
1A07	Next Generation Air Transportation System (NextGen) - Demonstrations and Infrastructure Development	$33.8	$30.0	$30.0	$30.0	$30.0
1A08	Next Generation Air Transportation System (NextGen) - System Development	$66.1	$70.8	$100.2	$101.0	$119.1
1A09	Next Generation Air Transportation System (NextGen) - Trajectory Based Operations	$63.5	$43.0	$32.0	$31.0	$28.0
1A11	Next Generation Air Transportation System (NextGen) - Arrivals/Departures at High Density Airports	$51.8	$38.0	$33.0	$35.0	$35.0
1A12	Next Generation Air Transportation System (NextGen) - Collaborative Air Traffic Management (CATM)	$44.6	$57.0	$53.0	$51.0	$44.0
1A13	Next Generation Air Transportation System (NextGen) - Flexible Terminal Environment	$64.3	$64.1	$45.2	$36.9	$18.0
2A01	En Route Automation Modernization (ERAM)	$171.8	$131.5	$130.0	$125.0	$129.0
2A02	En Route Communications Gateway (ECG)	$3.6	$16.3	$19.8	$18.5	$9.9
2A06	Air Traffic Management (ATM)	$31.4	$15.2	$8.5	$13.4	$8.1
2A11	Oceanic Automation System	$7.7	$9.8	$14.9	$12.1	$6.0
2A14	System-Wide Information Management (SWIM)	$54.6	$76.0	$22.5	$6.3	$3.9
2A18	Collaborative Air Traffic Management Technologies (CATMT)	$18.1	$49.5	$57.9	$66.8	$60.7
2B03	Standard Terminal Automation Replacement System (STARS) (TAMR Phase 1)	$28.0	$32.0	$41.8	$42.0	$39.5
2B04	Terminal Automation Modernization/ Replacement Program (TAMR Phase 3)	$3.0	$20.0	$65.0	$75.0	$86.7
2B05	Terminal Automation Program	$9.6	$6.0	$2.5	$2.5	$2.6
2B15	Integrated Display System (IDS)	$7.0	$8.7	$8.8	$8.2	$8.2
2B18X	Terminal Automation Modernization/ Replacement Program (TAMR Phase 2)*	$0.0	$2.8	$2.4	$3.0	$3.0
2D08	Instrument Flight Procedures Automation (IFPA)	$7.9	$0.5	$2.2	$1.8	$2.0
3A02	Aviation Safety Analysis System (ASAS) - Regulation & Certification for Infrastructure System Safety (RCISS)	$10.5	$14.6	$22.5	$8.9	$11.5
3A07	System Approach for Safety Oversight (SASO)	$20.0	$23.4	$37.1	$31.5	$9.5
3A08	Aviation Safety Knowledge Management Environment (ASKME)	$8.1	$14.8	$17.2	$6.9	$16.0
4A10	Aeronautical Information Management (AIM)	$10.0	$17.8	$18.3	$8.3	$7.6

Figure 7 Expenditures in the Automation Functional Area[1]

Figure 7 shows funding for systems that are shown in the roadmaps as well as the following systems that are part of the overall FAA Enterprise Architecture and support the safety functions of FAA:

- Instrument Flight Procedures Automation (IFPA)
- Aviation Safety Analysis System – Regulation and Certification Infrastructure System Safety (ASAS-RCISS)
- System Approach for Safety Oversight (SASO)
- Aviation Safety Knowledge Management Environment (ASKME)

The IFPA program automates the development of terminal approach and departure procedures. The other three systems support databases of safety information to assist safety inspectors in reviewing the performance of flight crews and companies that provide aviation services. All are ongoing efforts to increase the efficiency and effectiveness of Industry safety practices

4.2 Communications Roadmaps

Communication between pilots and controllers is an essential element of air traffic control. Pilots and controllers normally use radios for communication, but because control sectors cover areas that extend beyond direct radio range, they need supplemental links. Remotely located

[1] Out-year funding amounts are estimates that assume enactment of the Administration's reauthorization proposal.

radio sites allow controller-pilot voice communications beyond normal radio range by transmitting messages received at a remote site to air traffic control facilities through ground telecommunication lines. If no ground links are available, satellite links can be used to connect pilots with controllers. To minimize the impact of losing a primary communication link, backup systems are necessary to provide continued ability to communicate when the primary systems fail.

In addition to communicating with pilots, controllers must communicate with controllers within their own facility and controllers in adjacent facilities. Voice switches in air traffic facilities allow controllers to select among the different channels they need to communicate with one another and with pilots. Figure 8 is the roadmap for modernizing these systems and the other system on the roadmap that transfer data to FAA facilities.

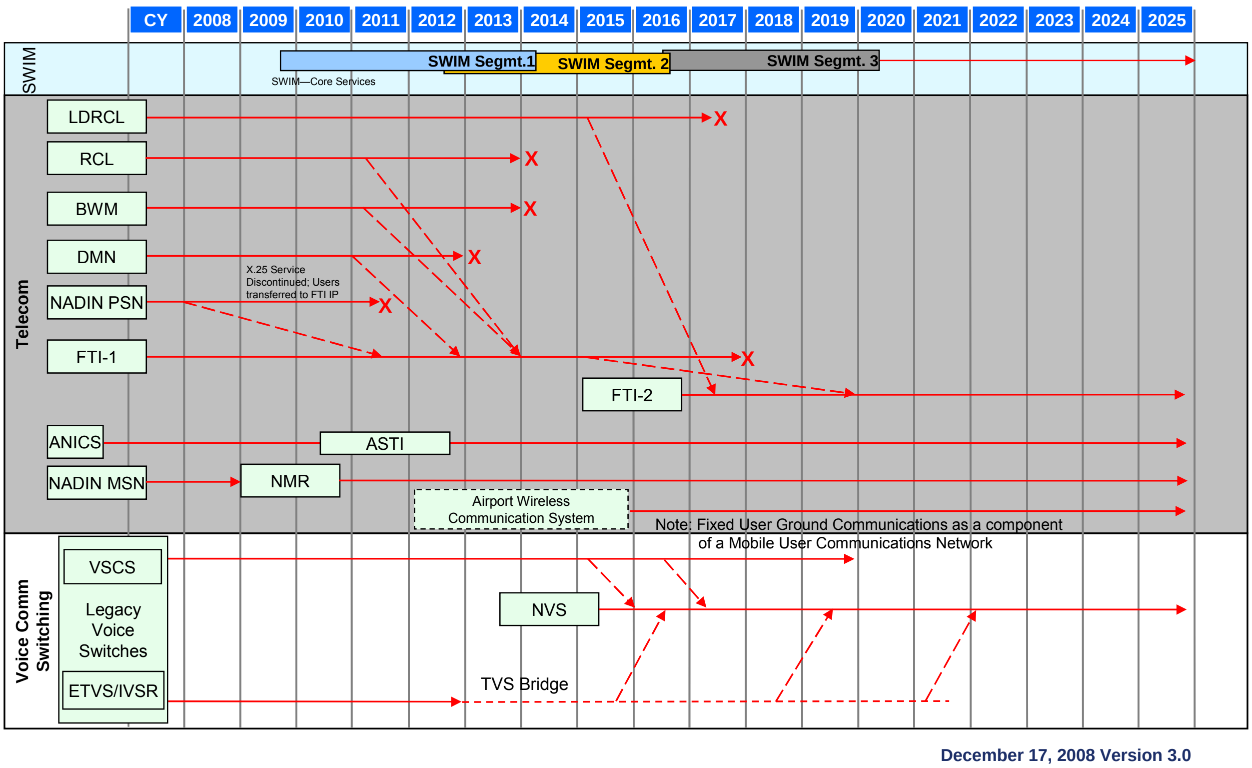


Figure 8 Communications Roadmap (1 of 2)

At the top of Figure 8 are the System-Wide Information Management (SWIM) program segments, which will establish information management and data-sharing capabilities to support NextGen. SWIM will develop policies and standards to support data management, along with the core services to enter data into NAS systems, retrieve it, secure its integrity, and control its access and use. The FAA is developing SWIM incrementally. Segment 1, the initial phase of SWIM, includes capabilities that were selected based upon the needs of various users (both government and private sector), maturity of design standards for concepts of use, and the ability of existing programs to integrate these SWIM capabilities into their program plans. Future segments will build on the initial steps to support the data sharing that NextGen programs require.

SWIM will reduce the number and types of interfaces between NAS systems, reduce unnecessary redundancy of information systems, improve predictability and operational decision-making, and reduce cost of service. The improved coordination that SWIM will provide will enable the FAA to transition from tactical conflict management of air traffic to strategic trajectory-based operations.

Below SWIM is a list of several FAA communication systems used mainly for transmitting data. The LDRCL (Low Density Radio Communication Link) and the RCL (Radio Communication Link) are microwave systems that transmit radar data from remote radar sites to FAA air traffic control facilities; they can also transmit operational and administrative information to and from air traffic control facilities. Current plans are to eliminate these systems by 2014 and use the FAA Telecommunications Infrastructure (FTI) to carry this data. The Band Width Manager (BWM) improves efficiency of information flow on the microwave network. It will not be needed when the FAA shuts down RCL and LDRCL. The NADIN PSN (National Airspace Data Interchange Network – Package Switching Network) and DMN (Data Multiplexing Network) transmit flight plans and other important aeronautical information to air traffic facilities. The DMN is a system that improves efficiency of message transmission by dividing messages into packages and sending packages from multiple messages at the same time to make fuller use of communication links. The packages are coded, and each message is reassembled at the receiving end. The FAA will replace NADIN PSN with NADIN MSN (Message Switching Network) to comply with international standards for transmitting flight plans. Some functions of NADIN PSN and DMN will be absorbed into the FAA Telecommunications Infrastructure and its follow on contract.

The Alaska National Airspace System Interfacility Communications System (ANICS) consists of ground stations that send and receive data from communications satellites to connect the operational facilities in Alaska. The ASTI (Alaska Satellite Telecommunications Infrastructure) program is a follow-on to ANICS, and it provides the same services while modernizing the infrastructure. Because there are far fewer ground telecommunications connections in Alaska, we use a satellite system to ensure that important air traffic information is reliably transmitted between smaller and larger facilities. Previous commercial satellite service did not meet FAA standards for reliability and availability.

The Voice Comm Switching block in Figure 8 shows the voice switching systems that FAA facilities use. En route centers use the Voice Switching and Control System (VSCS) to connect controllers with the appropriate telecommunications line to speak to pilots, controllers in other facilities, and controllers within their own facility. The Enhanced Terminal Voice Switch (ETVS) and the Interim Voice Switch Replacement (IVSR) contracts fulfill the same function in airport towers and Terminal Radar Approach Control (TRACON) facilities. The FAA is upgrading the VSCS with a technical refresh to replace components that have a high failure rate. The ETVS and IVSR programs are replacing terminal voice switches at the rate of about 10 per year, as well as installing new voice switches when new airport traffic control towers are built.

The FAA has begun developing requirements for the NAS Voice Switch (NVS), a single scalable design that would replace both center and terminal voice switches and equip NextGen facilities. It would have a modular configuration so that it could be sized for the facility in which it was installed. The value of using a single type of voice switch is that it reduces the number of training courses for maintenance technicians and the inventory of spare parts to maintain it. NVS also enables operation of planned NextGen facilities. The FAA plans to begin installing the system in 2013, and, by 2023, all the voice switches will be NVS.

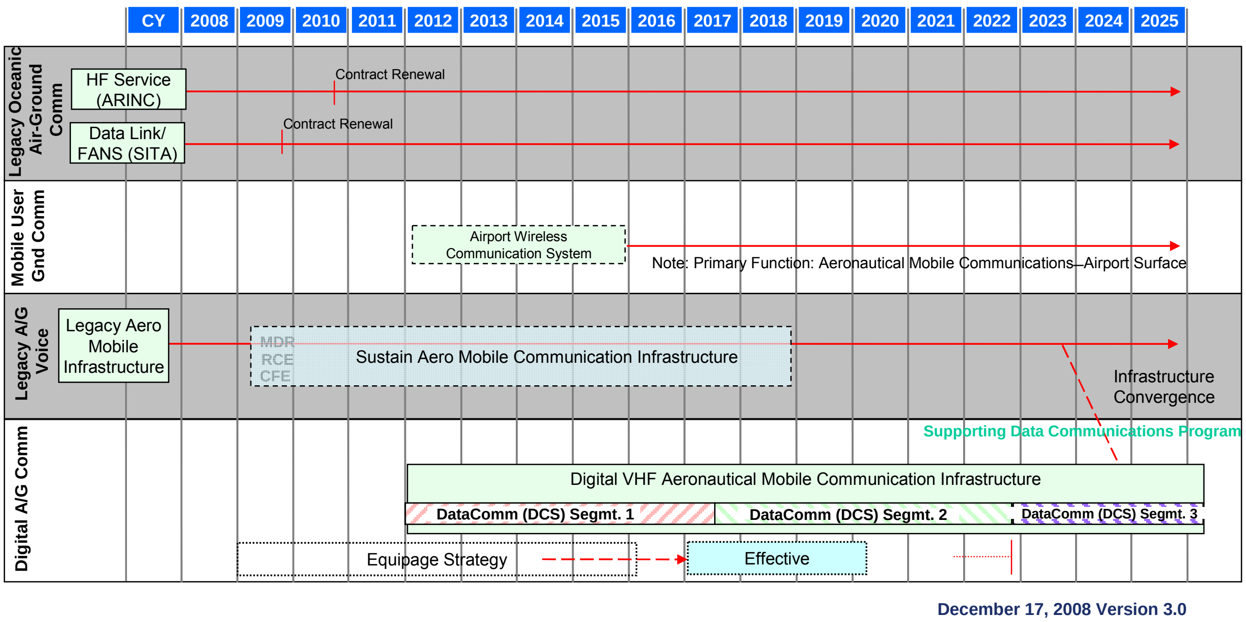


Figure 9 Communications Roadmap (2 of 2)

The second roadmap (Figure 9) shows the communications systems used both on the ground and in the aircraft for air traffic control. In the oceanic control area, the universal system is HF (high frequency) radio. Operated by a company named ARINC, HF allows the FAA to stay in touch with aircraft that are several thousand miles from shore. HF is supplemented by Data Link (FANS) Future Air Navigation System, which relies on communications satellites to transfer messages over long distances. The Legacy A/G (air/ground) Voice box indicates that FAA will continue to sustain the very high frequency/ultra high frequency (VHF/UHF) radios used for controller-pilot communications. The MDR (multimode digital radio) is replacing existing VHF/UHF equipment with modern systems capable of operating in either analog or digital modes. The RCE (Radio Control Equipment) program replaces the control system that allows controllers to activate and use radios at remote locations. The Communications Facilities Expansion (CFE) program funds establishment or relocation of remote communications sites when necessary to serve new or relocated air routes.

An Airport Wireless Communications System based on existing IEEE 802.16e standards is being considered to provide communications for both fixed and mobile units on the airport surface. This technology could be a low cost alternative for supporting existing and future applications associated with ASDE-X, ADS-B and SWIM in the airport environment.

Starting in 2009, the FAA will be developing digital communications with data link capability (DataComm) for pilot-controller communications. Initially, DataComm will be used for routine messages such as air traffic clearances, advisories, flight crew requests, and reports. As the technology matures, the FAA may be able to issue an entire route of flight directly to an aircraft's flight management system.

Figure 10 shows the projected CIP spending for replacing communications systems and improving and modernizing communications channels.

BLI Number	Program Name	FY 2010 Budget	FY 2011	FY 2012	FY 2013	FY 2014
	Communication Functional Area	**$215.4**	**$295.4**	**$354.8**	**$505.5**	**$823.7**
1A06	Data Communication in support of Next Generation Air Transportation System	$51.7	$132.8	$214.6	$389.5	$714.7
2A07	Air/Ground Communications Infrastructure	$8.6	$2.5	$2.8	$2.0	$2.0
2A10	Voice Switching Control System (VSCS)	$16.7	$15.9	$0.0	$0.0	$0.0
2A13	Next Generation VHF Air/Ground Communications System (NEXCOM)	$70.2	$60.5	$64.7	$52.0	$45.0
2B08	Terminal Voice Switch Replacement (TVSR)	$10.5	$0.0	$0.0	$0.0	$0.0
2B13	National Airspace System Voice Switch (NVS)	$26.6	$50.0	$50.0	$50.0	$50.0
2B14	Voice Recorder Replacement Program (VRRP)	$11.9	$9.6	$0.0	$0.0	$0.0
2E05	Alaskan NAS Interfacility Communications System (ANICS)	$9.0	$12.1	$10.7	$0.0	$0.0
3A04	National Airspace System (NAS) Recovery Communications (RCOM)	$10.2	$12.0	$12.0	$12.0	$12.0

Figure 10 Expenditures in the Communications Functional Area[2]

4.3 Surveillance

To provide separation services to aircraft, air traffic controllers must have an accurate display of all aircraft under their control. Controller displays use a variety of inputs, including radar and transponder information to show the location of aircraft. Automation systems process radar data and other inputs and send it to the displays. En route facilities use the Air Route Surveillance Radar (ARSR), and terminal facilities use several models of the Airport Surveillance Radar (ASR) as primary radars. The ARSR and ASR radars are primary because they do not require a cooperative transmission from an aircraft to detect and track its location. En route and terminal facilities normally use secondary radars called the Air Traffic Control Beacon Interrogators (ATCBI) and Mode Select (Mode S) for traffic separation. Secondary radar sends a signal to aircraft equipped with a transponder. The transponder sends a reply, which can be processed to determine the aircraft call sign, altitude, speed, and its position. Using ATCBI or Mode S enhances the controller's ability to separate traffic because flight and altitude information can supplement the position display for each aircraft.

We use two systems for tracking aircraft on or near the airport surface. The ASDE-3 is a primary radar system that provides a display of aircraft and ground vehicles in the airport operating areas (runways and taxiways). This helps controllers manage aircraft on the ground and warn them of potential runway incursions. The ASDE-X uses several technologies to improve detection of aircraft and provide a clear display of the positions of aircraft and vehicles on or near taxiways and runways.

[2] Out-year funding amounts are estimates that assume enactment of the Administration's reauthorization proposal.

Figure 11 is the roadmap for surveillance systems.

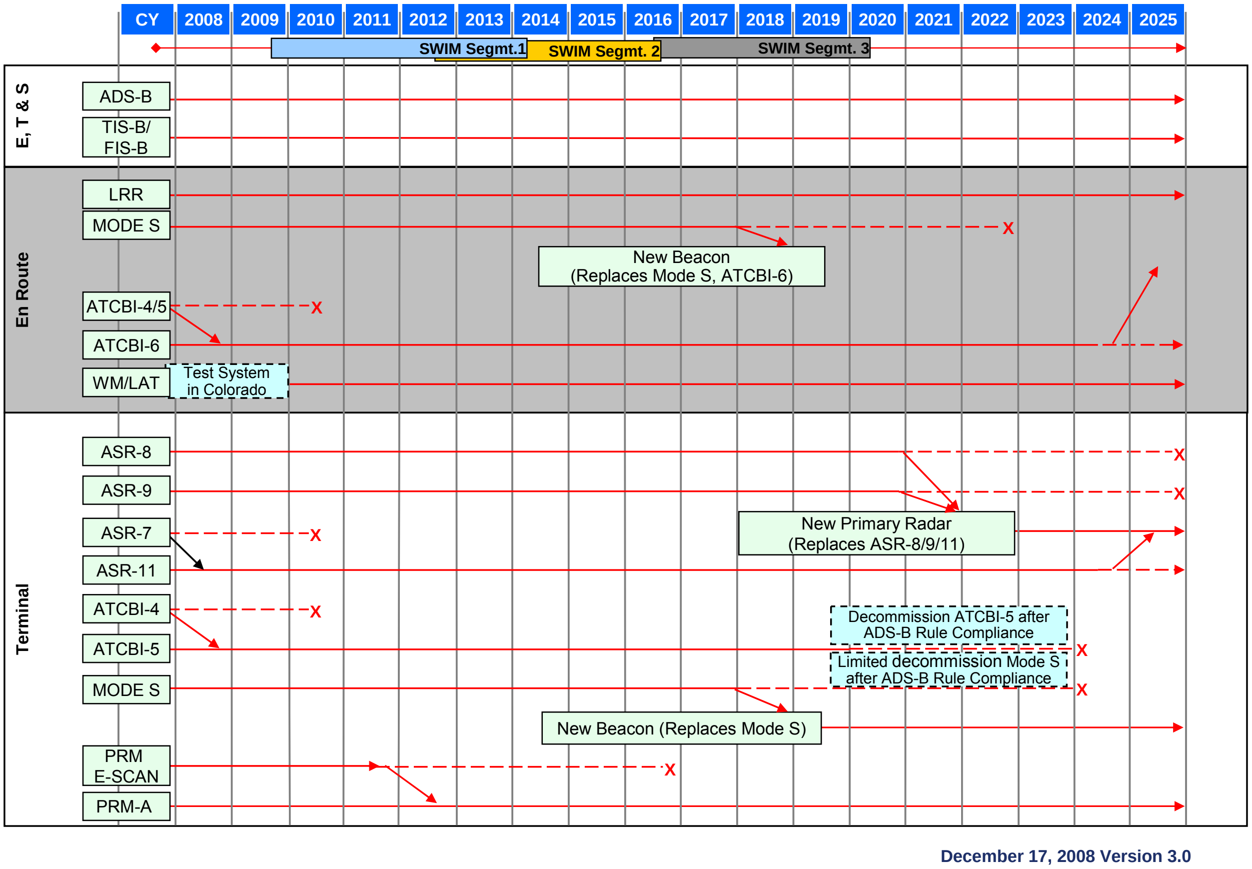


Figure 11 Surveillance Roadmap (1 of 2)

The Automatic Dependent Surveillance-Broadcast (ADS-B) line at the top of the roadmap indicates a planned shift toward a different technology for providing surveillance data to controllers. Nationwide implementation of ADS-B will enable a once-per-second transmission of location and other flight information from the aircraft to air traffic control facilities. It may replace or supplement the data from a transponder response or passive reflected energy from radars. The advantage of ADS-B is that it has a faster update rate (1 second versus 5 seconds for a radar), and the accuracy remains constant regardless of the distance from the aircraft to the receiving site, unlike radar technology where accuracy changes with distance from the radar.

The major systems shown in the block for en route are the Long Range Radar (LRR — a generic term for the various ARSR models); the Air Traffic Control Beacon Interrogator (ATCBI); and the Mode S. The LRR has a range exceeding 200 miles, and it provides aircraft location information to the en route centers. It is a "skin-paint" radar that sends out electrical pulses and determines aircraft location by combining information on the direction the antenna is pointing and the time it takes the reflected energy to return to the radar antenna. The ATCBI or Mode S transmits an electronic signal to aircraft, which triggers a transponder. The ATCBI triggers all transponders within its beam, while the Mode S is able to address each aircraft within its beam separately.

Due to national and homeland security concerns, we will maintain the LRR throughout the roadmap timeframe. The FAA and the Department of Defense will jointly fund the maintenance required to keep the existing systems operational. We are replacing the ATCBI 4/5 with the ATCBI-6 and plan to decommission the 4s and 5s in 2010. We may start phasing out the Mode S in 2017 and decide in 2011 whether we need a New Beacon system to support NextGen.

The Wide Area Multilateration (WM/LAT) system is experimental, and is being tested in Colorado. The system uses triangulation, based on ADS-B technology, to determine the location of an aircraft that cannot be detected by radar. In mountainous terrain, the line-of-sight transmission from radar can be blocked by an intervening mountain between the radar and the aircraft; the WM/LAT system overcomes this problem. It is being locally financed and may be implemented in other mountain regions if it proves to be successful.

There are four models of terminal radars currently in use. The Airport Surveillance Radar Model 11 (ASR-11) is the newest, and it is replacing some of the older radars that were not replaced by the ASR-9 program. As shown in the roadmap, the FAA will replace all the existing ASR-7s by 2010. The ASR-8 and the ASR-9 will have Service Life Extension Programs (SLEP) to update and modernize their components, and the FAA will decide in 2014 whether to continue to update these systems or to design a replacement. Current planning calls for keeping terminal skin-paint radars operational to address safety and weather requirements.

The Precision Runway Monitor (PRM) is installed at six airports, and it can be used to allow simultaneous approaches to closely spaced parallel runways. It is a rapid-update radar that provides the precision that controllers need to ensure two aircraft approaching runways side by side maintain safe clearance between them. The electronic scan (E-SCAN) version achieves the rapid update by moving the beam electronically rather than relying on a turning antenna. The FAA will decide in 2010 whether to continue using a scanning beam or to rely on multilateration similar to the ASDE-X.

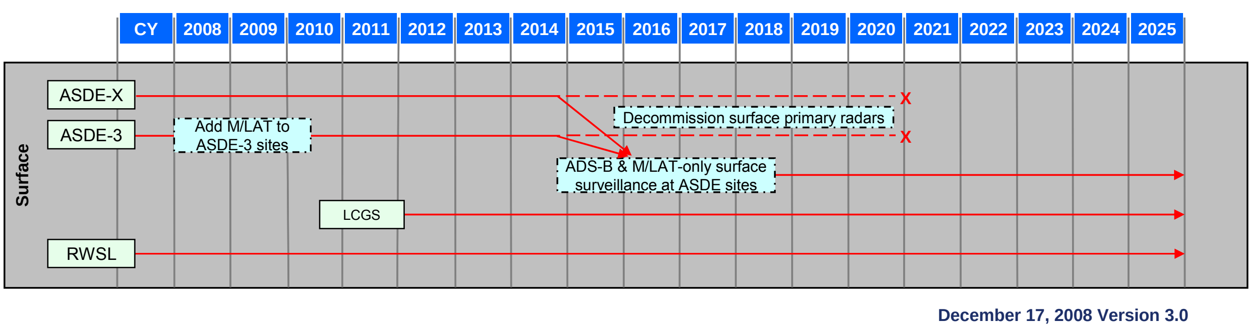


Figure 12 Surveillance Roadmap (2 of 2)

Controllers use two systems to maintain aircraft separation on the airport surface. Some airports have ASDE-3, which uses radar and a display in the tower to depict the location of aircraft on or approaching the taxiways and runways. These displays help controllers determine aircraft location when weather or darkness makes it difficult to see the airport surface. The ASDE-X uses several technologies to perform the same function. We plan to upgrade 21 of the existing ASDE-3 radars with multilateration technology to enhance their effectiveness, and ASDE-X will replace 4 existing ASDE-3 radars. We are accelerating installations of ASDE-X so that by 2010 we will have installed all of these systems, and the final system will become operational in 2011.

The surface surveillance section of the roadmap shows that the FAA is developing a new system, the Low Cost Ground Surveillance (LCGS) system, for possible deployment in 2011. After testing competing designs for the LCGS, we will decide during 2010 which of the technologies has the best performance and whether to deploy the technology as a production system. LCGS would be used at small to medium-sized airports, and it would cost less than the ASDE-X or ASDE-3 with multilateration. Deploying LCGS would increase the number of airports that use sophisticated detection systems to show the location of aircraft and other vehicles near the runways and taxiways on tower displays, which would enhance our efforts to reduce runway incursions.

A third system that warns pilots about potential runway incursions is the Runway Status Lights (RWSL). These systems use lights embedded in the runway to inform a pilot when it is unsafe to cross a runway; and they are turned off when it is safe to proceed. We have tested these lights at Dallas/Fort Worth International Airport. The FAA has requested funding in FY 2010 to significantly increase the number of airports where we will install these systems as part of our goal to reduce runway incursions.

Figure 13 shows the CIP costs associated with upgrading the surveillance units.

BLI Number	Program Name	FY 2010 Budget	FY 2011	FY 2012	FY 2013	FY 2014
	Surveillance Functional Area	**$362.1**	**$270.6**	**$305.4**	**$291.0**	**$275.1**
2A08	ATC Beacon Interrogator (ATCBI) - Replacement	$4.7	$0.0	$0.0	$0.0	$0.0
2A09	Air Traffic Control En Route Radar Facilities Improvements	$5.3	$5.6	$5.8	$5.9	$0.9
2A15	Automatic Dependant Surveillance-Broadcast (ADS-B) NAS-Wide	$201.4	$175.2	$284.2	$270.7	$256.9
2B01	Airport Surface Detection Equipment - Model X (ASDE-X)	$17.3	$0.0	$2.2	$10.0	$11.1
2B10	Airport Surveillance Radar (ASR-9)	$3.5	$0.0	$0.0	$0.0	$0.0
2B11	Terminal Digital Radar (ASR-11)	$12.6	$4.1	$3.4	$4.4	$4.4
2B12	Runway Status Lights (RWSL)	$117.3	$85.7	$9.8	$0.0	$1.8

Figure 13 Expenditures in the Surveillance Functional Area[3]

4.4 Navigation Roadmaps

There are two major types of navigational aids: those used for en route navigation and those used for precision approach and landing guidance. The en route aids have traditionally been radio transmitters that provide pilots with direction and distance from their location. The ground-based system commonly used for en route navigation is the Very High Frequency Omnidirectional Range with Distance Measuring Equipment (VOR and DME). There are over

[3] Out-year funding amounts are estimates that assume enactment of the Administration's reauthorization proposal.

1,000 VORs spread across the United States. These navigational aids allow pilots to determine an accurate position and also help define the airways, which are routes based on the straight lines from VOR to VOR. Airways can simplify route planning and reduce the length of the clearances to fly from departure to destination, and they have the added value of providing predictability for air traffic controllers who often must project an aircraft's future position to avoid conflicts. Pilots use VOR/DME to follow their planned routes accurately under all visibility conditions.

As we implement NextGen and more aircraft equip, the Global Positioning System (GPS) satellite navigation system, will be more widely used for en route navigation. Using GPS will support more direct routing because pilots will have be able to program and fly routes defined by geographic coordinates rather than flying from VOR to VOR. GPS in the aircraft will also be used to report an aircraft's position when we implement ADS-B.

Precision landing guidance systems and the associated equipment supporting low visibility operations, provide radio signals and approach lights that pilots use to land safely in limited visibility. There are two precision landing aids. Instrument Landing Systems (ILS) guide pilots to runway ends using a radio beam to define the approach glideslope, which pilots can follow using cockpit instrumentation. There are more than 1,200 ILSs installed in the United States. They are essential to airlines for maintaining schedule reliability during poor weather. Augmented GPS satellite signals also provide precision landing guidance. There are two augmentation systems that will be used for this purpose. The Satellite Based Augmentation System (SBAS) is the FAA's Wide Area Augmentation System (WAAS) that uses 38 ground monitors to calculate corrections to the GPS signals and broadcast those corrections from telecommunications satellites so that properly equipped aircraft can use the information to fly a precision approach to a runway in low visibility conditions. There are currently more than 1,300 WAAS precision approach procedures that are referred to as Localizer Performance with Vertical Guidance (LPV) which use GPS augmented by WAAS for both horizontal and vertical guidance. The Ground Based Augmentation System (GBAS) is the FAA's Local Area Augmentation System (LAAS), which is located on an airport's surface and calculates corrections that are used to provide precision approach services to all runways at an airport in weather conditions approaching zero visibility.

Figures 14 and 15 show the roadmaps for navigation aids.

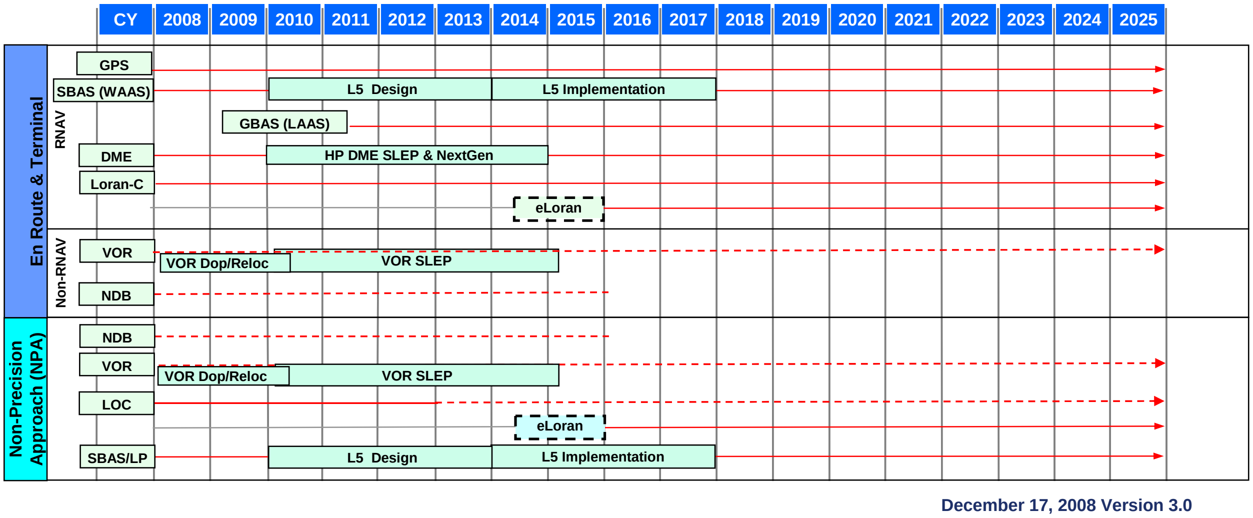


Figure 14 Navigation Roadmap (1 of 2)

The en route and terminal domains have traditionally relied on the system of VORs to define airways within the NAS. The FAA decided in 2007 to reduce the number of VORs between now and 2025 as part of the transition to satellite-based navigation. The FAA will decide in 2015 whether to continue operating VORs as a backup for GPS or remove all the VORs by 2025. If we retain VORs, they will need a service life extension program (SLEP).

We will keep Distance Measuring Equipment (DME) in service to support Area Navigation/Required Navigation Performance/ (RNAV/RNP) for en route and terminal navigation services. We will install additional DME in both terminal and en route airspace to support the capability of NextGen to handle increased demand for services.

The FAA is phasing out and plans to decommission Non-Directional Beacons (NDB) by 2015. NDBs provide only limited directional information.

The Department of Defense operates GPS. There are typically 24 to 30 active satellites in orbit, and a navigation receiver can determine an aircraft's position by interpreting the data transmitted by all the satellites in view. Two GPS upgrades are expected in future years. The next generation of satellites, Block IIF, will have a second frequency (L5) for civilian safety-of-life use. An aircraft receiver that receives both the existing L1 signal and the new L5 signal can calculate corrections to account for atmospheric distortion. The GPS III family of satellites will be upgraded with an additional civil signal (L1C) and increased transmitting power.

The WAAS (Wide Area Augmentation System) improves the precision of GPS by providing corrections and satellite reliability information to aeronautical GPS receivers. The receivers use WAAS corrections to calculate a precise geographic position. That precision will be further improved with introduction of the L5 signal. By comparing the information received on the two separate signals, receivers will be able to correct for ionospheric disturbances caused by solar weather events, which will significantly improve availability of LPV approaches.

GPS III civil-unique requirements development will be another enhancement to the GPS constellation, and civilian agencies will fund it. This program will develop GPS signal monitors to determine whether the civilian frequencies being added to GPS satellites are within required tolerance.

Non-precision approaches provide guidance to pilots preparing to land on a runway when there is limited visibility, but only provide lateral, not vertical guidance. These approaches do not allow descent to the same minimum altitudes possible with a precision approach. VORs support many of the non-precision approaches, and GPS and WAAS also support non-precision approach services. If the FAA decides to decommission VORs, GPS and WAAS will become the primary means for providing this service. The FAA has more than 4,000 GPS-WAAS non-precision approach procedures in place.

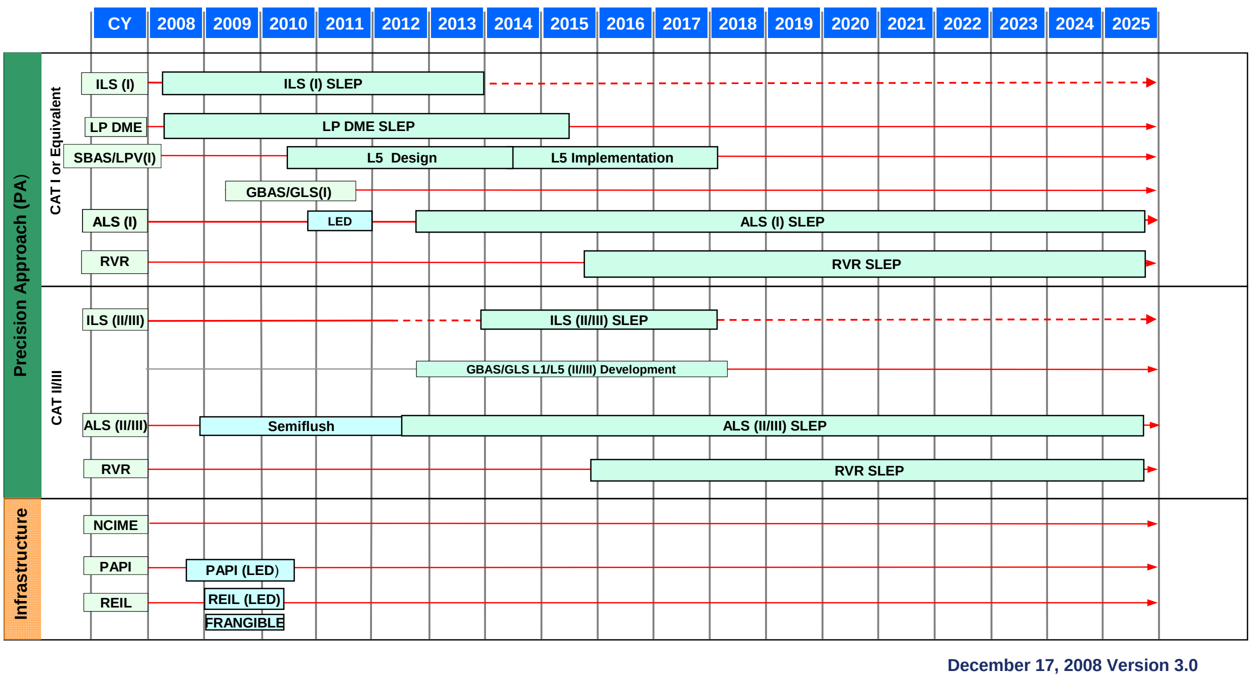


Figure 15 Navigation Roadmap (2 of 2)

There are three categories of precision approach. Category I is the most common. The Category I approach guides the pilot to the runway end, but it requires that the pilot be able to see the runway when the aircraft is no less than 200 feet above the field elevation, and the horizontal visibility is a half mile or more. The Category II and III approaches have lower minimums (i.e., less vertical and horizontal visibility is required). Currently only the ILS is accurate enough for these categories of precision approach, because Category II and III ILS have the redundancy and reliability that reduce the risk of errors when descending to lower minimums. Alternatives for precision approach guidance are the WAAS/LPV (Localizer Performance with Vertical Guidance) and LAAS. When these alternatives become operational, many ILSs can be decommissioned, but a number will remain in service to provide a backup capability at the OEP airports and other airports as required.

In the precision approach section and in the infrastructure section, there are references to an Airport Lighting System (ALS), Runway End Identification Lights (REIL), and Precision Approach Path Indicator (PAPI). These systems help the pilot to visually align with the runway for both precision and non-precision approaches. The FAA is testing the use of light emitting diodes (LED) to replace the incandescent lamps currently in use in these systems to reduce both maintenance and operating costs. The Runway Visual Range (RVR) sensors, which determine the horizontal visibility along the runway will continue operating throughout the roadmap timeframe. The FAA is considering the Navaid Control and Interlock and Monitoring Equipment (NCIME) system for upgrading the control of navigational aids surrounding an airport.

Figure 16 shows the future capital investments for navigation systems included in the CIP.

BLI Number	Program Name	FY 2010 Budget	FY 2011	FY 2012	FY 2013	FY 2014
	Navigation Functional Area	**$187.8**	**$146.1**	**$141.9**	**$139.8**	**$132.4**
2D01	VHF Omnidirectional Radio Range (VOR) with Distance Measuring Equipment	$5.0	$5.0	$5.0	$2.5	$2.5
2D02	Instrument Landing Systems (ILS) - Establish	$8.6	$7.8	$5.0	$7.0	$7.0
2D03	Wide Area Augmentation System (WAAS) for GPS	$97.4	$101.1	$100.5	$100.3	$107.9
2D04	Runway Visual Range (RVR)	$5.0	$5.0	$5.0	$4.0	$4.0
2D05	Approach Lighting System Improvement Program (ALSIP)	$8.7	$5.0	$5.0	$3.0	$3.0
2D06	Distance Measuring Equipment (DME)	$6.0	$6.0	$5.0	$5.0	$0.0
2D07	Visual Navaids - Establish/Expand	$3.7	$3.2	$3.4	$5.0	$0.0
2D09	Navigation and Landing Aids - Service Life Extension Program (SLEP)	$6.0	$6.0	$6.0	$8.0	$3.0
2D10	VASI Replacement - Replace with Precision Approach Path Indicator	$4.0	$7.0	$7.0	$5.0	$5.0
2D11	GPS Civil Requirements	$43.4	$0.0	$0.0	$0.0	$0.0

Figure 16 Expenditures in the Navigation Functional Area[4]

4.5 Weather Systems

Timely and accurate weather observations and forecasts are essential to aviation safety and making the best use of aviation capacity. Pilots need to know whether winds aloft will make their actual speed more or less than the airspeed shown on their instruments and if there will be obstructions to visibility that restrict landings at their destination airport. They also need to check on whether the runway is wet or dry and how that will affect their braking action. Traffic flow managers and pilots must use weather observations and forecasts to determine when they need to plan alternative routes to avoid severe weather. Thunderstorms with hail and heavy rain, turbulence, and icing must be avoided because they can damage aircraft and potentially injure passengers. The FAA has the leading role in collecting and distributing aviation weather data. The agency distributes current weather hazard information from its own systems and uses computer models that develop forecasts based on data available from the National Weather Service for use by air traffic control facilities, pilots, airline operations centers, and other aviation-related facilities.

Two categories of weather systems that the FAA uses are weather sensors and weather processing/dissemination/display systems. Weather sensors include weather radars and surface observation systems that measure atmospheric parameters, such as surface temperature,

[4] Out-year funding amounts are estimates that assume enactment of the Administration's reauthorization proposal.

prevailing wind speed and direction, relative humidity, and bases and tops of clouds. Weather sensors provide real-time information to air traffic facilities and to centralized weather forecasting models that other agencies use. Weather processing/dissemination/ display systems organize and process the sensor's observed data. Data from multiple sensors feed forecast models, which can be disseminated and integrated in national and local processing and display systems to interpret broad weather trends affecting aviation operations. This information can then be sent to air traffic controllers and pilots. Figure 17 shows the current and planned status of weather sensors.

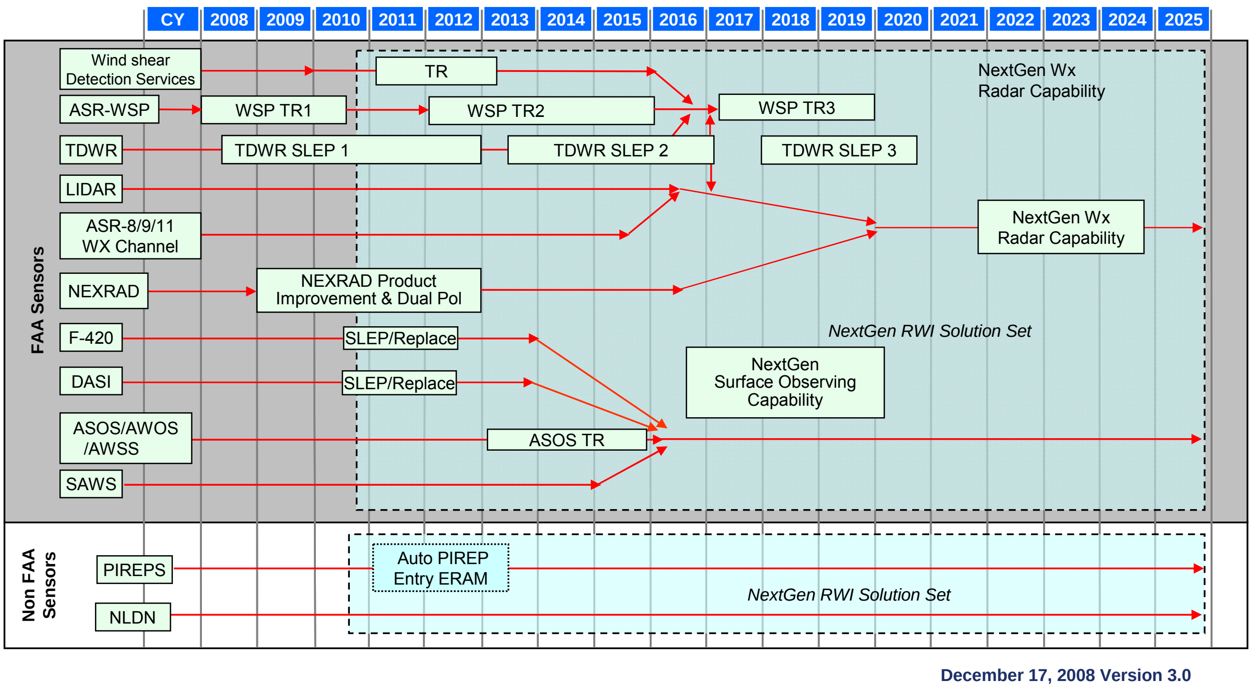


Figure 17 Weather Sensor Roadmap

The FAA sensors shown at the top of the roadmap include the Wind Shear Detection Services; the Airport Surveillance Radar – Weather System Processor (ASR-WSP); and the Terminal Doppler Weather Radar (TDWR). They all detect wind conditions near the surface of the airport to warn pilots of gust fronts and wind shear. The Light Detection and Ranging (LIDAR) system detects dry microbursts and gust fronts that TDWR may not detect. LIDAR is being evaluated at Las Vegas McCarran International Airport (LAS). It is one of four major airports located in dry high plains or an intermountain environment, where wind shear is not always accompanied by sufficient precipitation for the TDWR to detect it with 90 percent reliability. The evaluation of LIDAR will determine whether it is an acceptable alternative for other wind shear detection systems.

The ASR-9/11 Weather Channel and the Next Generation Weather Radar (NEXRAD) detect precipitation, wind, and thunderstorms that affect aircraft in flight. The F-420 and the Digital Altimeter Setting Indicator (DASI) are located in FAA facilities and display the current wind and barometric pressure for controllers. The Automated Weather Observing Systems

(AWOS/ASOS/SAWS) measure weather parameters on the surface to report conditions to air traffic facilities and pilots and also assist in weather forecasting.

Of the ground-based wind shear sensors, the most sophisticated is the TDWR. There are 46 operational TDWR sites located on or near the largest airports with the most risk of wind shear. Using Doppler technology, the radars can detect the rapid changes in wind speed and direction that indicate wind shear hazards for an aircraft approaching or departing a runway. Airports with significant wind shear risk that have a lower volume of air traffic are served by a lower cost alternative, the Airport Surveillance Radar-Weather System Processor (ASR-WSP). ASR-WSP uses two dimensional search radar signals to approximate the output of the TDWR.

To supplement these radar systems, Wind Shear Detection Services (WSDS), formerly known as LLWAS, consists of wind sensors located at 6 to 10 points around the runways to measure surface wind direction and velocity. The wind sensors and the associated computer systems determine whether wind shear and microburst events are occurring in the approach/departure corridors but do not detect them in other locations near the airport as a radar would. WSDS serve airports that do not have a TDWR or WSP as well as locations where they supplement the radars with point-specific wind measurements to verify the presence and location of wind shears. The WSDS program will collect data from each of the wind shear sensors to determine on a site-by-site basis what level of wind shear service should continue under NextGen. This data will also be used to decide in the 2018 timeframe whether to replace all current wind shear sensors with a NextGen weather radar system.

Replacing the ASR-8/9 weather channel will be necessary only if the ASR-8/9 do not remain in operation. The FAA plans to decide by 2018 whether to incorporate these functions into a combined NextGen weather radar replacement. The currently operating Next Generation Weather Radar (NEXRAD) was developed under a joint Department of Commerce National Weather Service, Department of Defense, and FAA program. These systems are Doppler weather radars that detect and produce over 100 different long-range and high-altitude weather observations, including areas of precipitation, winds, thunderstorms, turbulence, and icing. The NEXRAD radars are essential for forecasting future weather. In the short term, we are funding upgrades such as Dual Polarization (Dual Pol) and software improvements. Working with our partner agencies, we will also decide by 2018 whether to incorporate long-range NEXRAD functions that may be supplemented with intermediate range gap-filler functions into the combined NextGen weather and surveillance radar system.

The Automated Surface Observing Systems (ASOS) and other variants — such as the Automated Weather Observing System (AWOS); the Automated Weather Sensor Systems (AWSS); and the Stand Alone Weather Sensing (SAWS) system — have up to 14 sensors that measure surface weather data, including temperature, barometric pressure, humidity, type and amount of precipitation, and cloud bases and amount of sky cover. These systems feed data directly to air traffic control facilities and support automated broadcast of weather information to pilots. They also provide regular updates for the forecast models that predict future weather problems. The Digital Altimeter Setting Indicator (DASI) and the F-420 wind sensors, used by ATC towers, may require updating. We plan to work with our partner agencies and decide how their functions are incorporated into the NextGen Surface Observing Capability.

Pilot reports (PIREPS) of weather conditions can be transmitted by voice or automated systems to FAA facilities. We are studying whether these reports can be transmitted directly to air traffic automation systems in the future. The National Lightning Detection Network (NLDN) reports on the location of lightning strikes. The existing system or a modernized system will continue operating through 2025.

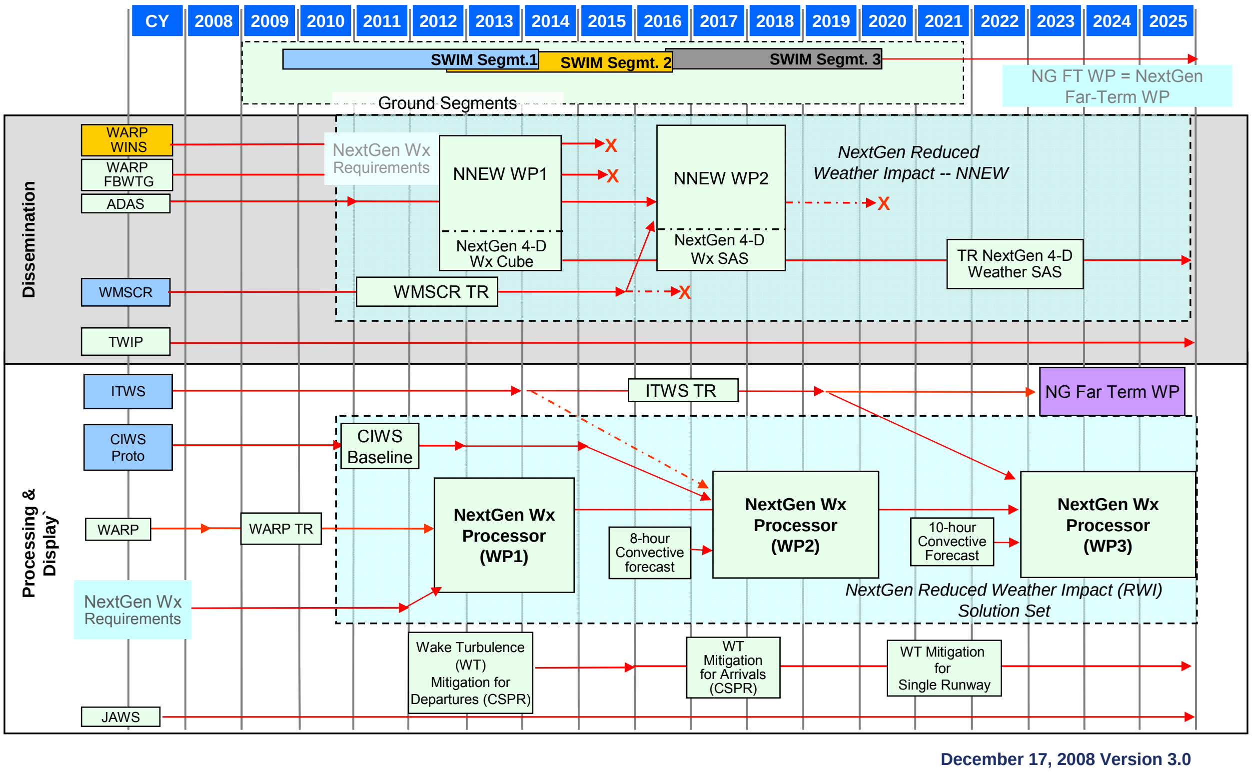


Figure 18 Weather Dissemination, Processing, and Display Roadmap

NextGen requires efficient consolidation of large volumes of weather observations and derived forecasts by processing, display, and dissemination systems that capture and process weather data and then integrate the resulting more sophisticated outputs into the decision software for advanced automation capabilities. NextGen Work Package 2 (WP 2) will enhance the display of weather information by using new algorithms to portray icing conditions, turbulence, and other hazards to aviation. Further upgrades of weather-predicting algorithms will be added by WP 3 such as wind shear/microburst and wake vortex detection and prediction.

The Weather and Radar Processor Weather Information Network Server (WARP WINS) stores data from multiple NEXRAD radars for use by en route control facilities. SWIM may distribute this data as a NextGen capability in the future. WARP compiles information for interpretation by the Center Weather Service Unit forecasting stations. WARP also feeds data to controllers' displays. The Automated Weather Observation Data Acquisition System (ADAS) is a radio link that transmits AWOS/ASOS/SAWS data to air traffic facilities. The FAA-operated Weather Message Switching Center Replacement (WMSCR) is a network with distribution nodes in Salt Lake City and Atlanta that collects and distributes nationwide weather information. The

Terminal Weather Information for Pilots (TWIP) system transfers TDWR weather information to FAA facilities and the airline's communication provider for uplink to pilots for use in analyzing terminal weather conditions. Current planning is that collection and storage of weather information will be a function of the SWIM network as part of Segment 3; however, the TWIP may continue as a NAS system. The FAA will decide during 2015 whether to integrate TWIP into the SWIM Air Segment.

The Integrated Terminal Weather System (ITWS) consolidates weather information from automated sensors and surrounding radars to provide real-time weather information for terminal control facilities. The system also projects movement of severe weather systems up to 20 minutes into the future. Tower and Terminal Radar Approach Control (TRACON) controllers use the information to make more precise estimates of when runways should be closed and subsequently reopened. They also use the information to plan for a switch in terminal arrival patterns to avoid excessive maneuvering to accommodate a runway change as aircraft approach an airport. The ITWS has been installed at 22 airports, and it is being deployed to 11 additional sites. ITWS will receive technical refresh in the near term, and the ITWS weather inputs and processing power will become part of the NextGen Automation Platform by 2023.

The Corridor Integrated Weather System (CIWS) gathers weather information occurring along the busiest air traffic corridors to help controllers select the most efficient routes when they must divert traffic to avoid severe weather conditions. The CIWS prototype tested a predictive capability that would refine the decisions on when normal (direct) routes will be available. This system will become part of the NextGen Weather Processor and support the Traffic Flow Management automation software.

The NextGen Weather Processor will incorporate the functionality of the existing Weather and Radar Processing (WARP) system. Work Package 2 (WP 2) will enhance the display of weather information by using new algorithms to portray icing conditions, turbulence, and other hazards. The ITWS functions will be incorporated as part of WP 3. Further upgrades of weather-predicting algorithms will also be added in WP 3 to include Wind Shear/Microburst and Wake Vortex Detection and prediction advisories.

The NextGen 4D Weather Cube is a distributed "virtual" database that will receive weather data directly from sensors and other sources, and, either automatically or by request, send data to FAA facilities so that observations and forecasts can be more widely and consistently distributed to a broad set of users via network enabled operations. The 4D Weather Cube will be part of the NextGen Networked Enabled Weather program and supports the Reduce Weather Impact solution set. The 4D Weather Cube will host the Single Authoritative Source (SAS), which ensures that the most accurate and consistent data will be distributed to users to ensure that decisions are based on correct and coherent weather information. Decision support tools will use this weather information to help users understand weather constraints and reduce risk for aviation operations.

The Juneau Airport Weather System (JAWS) is unique to the Alaska region. It provides wind hazard information from mountain peak wind sensors located around Juneau to the Flight

Service Station and Alaska Airlines to improve the safety of operations arriving and departing the airport.

Figure 19 shows the planned expenditures included in the CIP for weather sensors and weather dissemination and processing systems.

BLI Number	Program Name	FY 2010 Budget	FY 2011	FY 2012	FY 2013	FY 2014
	Weather Functional Area	**$104.5**	**$149.4**	**$145.7**	**$156.9**	**$120.7**
1A05	NextGen Network Enabled Weather (NNEW)	$20.0	$43.0	$56.4	$36.6	$33.8
1A10	Next Generation Air Transportation System (NextGen)-Reduce Weather Impact	$35.6	$64.3	$66.7	$109.8	$77.0
2A03	Next Generation Weather Radar (NEXRAD)	$6.9	$6.7	$2.8	$3.3	$1.2
2A12	Corridor Integrated Weather System (CIWS)	$2.3	$5.5	$3.0	$0.0	$0.0
2A16	Windshear Detection Service	$1.0	$0.0	$0.0	$0.0	$0.0
2A17	Weather and Radar Processor (WARP)	$17.6	$6.7	$1.8	$0.7	$0.7
2B02	Terminal Doppler Weather Radar (TDWR) - Provide	$9.9	$8.6	$7.7	$2.1	$0.5
2B16	Integrated Terminal Weather Systems (ITWS)	$1.9	$4.7	$0.0	$0.0	$1.3
2C01	Automated Surface Observing System (ASOS)	$5.5	$6.7	$2.5	$0.0	$0.0
2C03	Weather Camera Program	$3.8	$3.2	$4.8	$4.4	$6.2

Figure 19 Expenditures in the Weather Functional Area[5]

4.6 Facilities

The Air Traffic Organization maintains and operates thousands of staffed and unstaffed operational facilities that we must regularly upgrade and modernize. The largest facilities are the 21 en route centers, which house hundreds of employees and equipment to control aircraft flying in the en route airspace. The other operational facilities with significant staffing are the more than 500 towers and 167 TRACON facilities that control traffic departing and arriving at airports.

There are also more than 16,000 unstaffed facilities—many in very remote locations—supporting communications, navigation, and surveillance equipment and weather sensors. Much of this equipment is housed in shelters and buildings that have exceeded their service lives and need renovation. Many have deteriorating steel towers and foundations. Some newer unstaffed buildings and structures frequently need renovation because they are in remote and/or hostile locations near the ocean or on mountaintops. Replacing roofing, power, heating/cooling, and structural and security components of these structures is essential to successful operation of the NAS.

The William J. Hughes Technical Center (WJHTC) in Atlantic City, NJ, and the Mike Monroney Aeronautical Center (MMAC) and FAA Depot in Oklahoma City, OK, have many buildings. Each year, these complexes receive funds to both sustain and replace infrastructure and to improve and modernize buildings to support training, logistics, research, and management functions. The MMAC operates under a lease from the Oklahoma City Trust, and funds are requested to pay the annual lease costs. The MMAC also receives infrastructure funding for building renovation and updated infrastructure. The WJHTC supports research programs and testing of new equipment that will be installed in the NAS. The FAA has requested funding for 2010 and beyond to upgrade buildings and infrastructure such as roads. In addition, funding is

[5] Out-year funding amounts are estimates that assume enactment of the Administration's reauthorization proposal.

provided to reconfigure the research laboratories to accommodate acceptance testing for new equipment and to test modifications to existing equipment.

There are two budget line items for tower and TRACON investments, which have significant funding. The first is the Terminal Air Traffic Control Facilities – Replace program, which includes funding for both airport traffic control towers (ATCT) and TRACON facilities. This line item funds both replacement of existing towers and TRACONs and construction of towers for new airports. In most years, there are between 10 and 20 projects to replace towers that are too small to handle the traffic growth that has occurred since they were built or have inadequate sight lines due to construction of new runways or new hangers. The second line item is the Terminal Air Traffic Control Facilities – Modernize program which replaces specific exterior or interior components of existing towers, such as elevators; heating ventilation and cooling equipment; roofs; or other infrastructure that the FAA must upgrade to keep towers functioning.

The FAA invests about $50 million a year to upgrade and improve Air Route Traffic Control Center (ARTCC) facilities. Projects include expanding the size of the facility, replacing heating and cooling systems, and upgrading electrical power distribution systems.

Over the next 2 years, the FAA will evaluate the design and configuration of future NextGen facilities to ensure that these facilities will support the planned NextGen improvements in service and the potential changes in airspace controlled by these facilities. It is important that these new facilities are sized correctly so the full benefits of the NextGen Architecture can be realized. The potential benefits include accommodating NextGen capabilities such as Integrated Arrival and Departure Services, High Altitude Generic En Route Services, Flexible Airspace Management, Staffed NextGen Towers and integrated business continuity services. If the studies show that benefits will exceed costs, the FAA may begin transforming facilities starting in 2014.

Figure 20 shows the planned expenditures for facilities projects that contribute to modernizing the air traffic control system.

BLI Number	Program Name	FY 2010 Budget	FY 2011	FY 2012	FY 2013	FY 2014
	Facilities Functional Area	**$542.5**	**$697.9**	**$794.4**	**$905.2**	**$738.9**
1A03	William J. Hughes Technical Center Facilities	$12.0	$12.0	$12.0	$12.0	$12.0
1A04	William J. Hughes Technical Center Infrastructure Sustainment	$5.5	$5.6	$5.7	$5.9	$6.0
1A15	Next Generation Air Transportation System (NextGen) - Networked Facilities	$24.0	$160.4	$213.4	$337.8	$166.9
2A04	Air Traffic Control System Command Center (ATCSCC) Relocation	$10.3	$2.1	$2.1	$0.0	$0.0
2A05	ARTCC Building Improvements/Plant Improvements	$51.3	$57.0	$62.0	$62.4	$62.4
2B06	Terminal Air Traffic Control Facilities - Replace	$176.0	$145.0	$160.0	$165.0	$170.0
2B07	ATCT/Terminal Radar Approach Control (TRACON) Facilities - Improve	$38.9	$48.0	$53.3	$52.7	$52.7
2C02	Flight Service Station (FSS) Modernization	$20.1	$22.3	$16.5	$8.5	$2.5
2E01	Fuel Storage Tank Replacement and Monitoring	$6.2	$6.3	$6.4	$6.6	$6.7
2E02	Unstaffed Infrastructure Sustainment (formerly FAA Buildings and Equipment)	$18.2	$15.0	$15.7	$16.3	$16.5
2E04	Airport Cable Loop Systems - Sustained Support	$6.0	$5.0	$5.0	$5.0	$5.0
2E06	Facilities Decommissioning	$5.0	$5.0	$5.0	$5.0	$0.0
2E07	Electrical Power Systems - Sustain/Support	$101.0	$147.5	$160.0	$165.0	$170.0
3A01	Hazardous Materials Management	$20.0	$20.0	$20.0	$20.0	$20.0
3A05	Facility Security Risk Management	$18.0	$20.0	$30.0	$15.0	$19.4
3B01	Aeronautical Center Infrastructure Modernization	$13.8	$10.1	$10.3	$10.5	$10.8
4A04	Mike Monroney Aeronautical Center Leases	$16.2	$16.6	$17.0	$17.5	$17.9

Figure 20 Expenditures in the Facilities Functional Area[6]

4.7 Support Contracts and Automated Management Tools and Processes

The FAA has several support contracts and automated management tools that help our employees plan and manage modernization of existing systems; develop detailed transition plans to install new equipment; and oversee installing that equipment. The System Engineering and Technical Assistance contract and the Center for Advanced Aviation System Development contract help us plan overall modernization and simulate the impact of implementing new concepts and new equipment on our ability to manage air traffic. The Technical Support Services program provides field engineers who oversee site preparation and installation of new equipment in addition to supporting environmental projects to remove asbestos, improve fire life safety, and abate environmental pollution. These engineers and technicians help the FAA keep installation and other NAS projects on schedule, including projects with equipment deliveries and those associated with relocation and/or removal of equipment. The National Implementation Support Contract helps plan our transition to new equipment. Since air traffic control functions must continue while we install new equipment, we must prepare detailed plans before we begin installation to minimize any disruption.

Another category of support contracts covers leasing, modifying, or modernizing buildings to house engineering and training. The FAA also leases or purchases computer automation to support these engineering functions. Examples include improving the System Support Lab and licensing fees for software used for the WJHTC. In addition, there are support contracts to provide spectrum engineering to allocate radio frequencies for new installations and to prevent outside interference with existing frequencies.

[6] Out-year funding amounts are estimates that assume enactment of the Administration's reauthorization proposal.

BLI Number	Program Name	FY 2010 Budget	FY 2011	FY 2012	FY 2013	FY 2014
	Mission Support Functional Area	**$327.5**	**$322.6**	**$323.8**	**$314.3**	**$304.9**
1A01	Advanced Technology Development and Prototyping (ATDP)	$41.8	$37.5	$33.9	$30.4	$28.1
1A02	NAS Improvement of System Support Laboratory	$1.0	$1.0	$1.0	$1.0	$1.0
1A14	Next Generation Air Transportation System (NextGen) - Safety, Security, and Environment	$8.2	$8.0	$10.0	$10.0	$8.0
2B09	NAS Facilities OSHA and Environmental Standards Compliance	$26.0	$26.0	$26.0	$26.0	$26.0
2B18	Remote Maintenance Monitoring	$1.0	$0.0	$0.0	$0.0	$0.0
2E03	Aircraft Related Equipment Program	$10.0	$9.0	$13.0	$9.0	$9.0
2E09	Aircraft Fleet Modernization	$6.0	$0.0	$9.0	$0.0	$0.0
2E09X	Independent Operational Test/Evaluation - Outyear request	$0.0	$5.0	$5.2	$5.3	$5.5
3A03	Logistics Support Systems and Facilities (LSSF)	$9.3	$11.5	$0.8	$0.0	$0.0
3A06	Information Security	$12.3	$12.0	$12.0	$12.0	$12.0
3A09X	Logical Access Control	$0.0	$10.2	$9.0	$10.0	$0.0
3B02	Distance Learning	$1.5	$1.0	$1.0	$1.0	$1.0
3B03	National Airspace System (NAS) Training - Simulator	$6.7	$0.0	$0.0	$0.0	$0.0
4A01	System Engineering and Development Support	$31.7	$32.3	$32.9	$33.5	$34.1
4A02	Program Support Leases	$37.5	$38.6	$39.7	$40.9	$42.1
4A03	Logistics Support Services (LSS)	$11.0	$8.5	$8.5	$8.5	$8.5
4A05	Transition Engineering Support	$15.0	$15.0	$15.0	$15.0	$15.0
4A06	Frequency and Spectrum Engineering	$3.6	$2.0	$0.0	$0.0	$0.0
4A07	Technical Support Services (TSS)	$22.0	$22.0	$22.0	$25.0	$30.0
4A08	Resource Tracking Program (RTP)	$4.0	$4.0	$4.0	$4.0	$0.0
4A09	Center for Advanced Aviation System Development (CAASD)	$79.0	$79.0	$80.8	$82.7	$84.6

Figure 21 Expenditures in the Mission Support Functional Area[7]

Figure 21 shows planned expenditures for specific mission support projects that will help us modernize the air traffic control system.

[7] Out-year funding amounts are estimates that assume enactment of the Administration's reauthorization proposal.

5 Conclusion

Predicting the exact changes in air traffic workload over the next few years is quite challenging because there are significant recent downward trends in many economic measures, and the uncertainty about the direction these measures are heading makes forecasting the future more uncertain. FAA workload is closely correlated with Gross Domestic Product, and determining the full implications of these trends on aviation activity will depend on the economy becoming more stable. There are some positive economic factors such as the reduction in fuel prices that partially offset the negative changes, but the majority of economic indicators are affecting air travel negatively. To adjust to current conditions airlines have reduced operations, and the sale of business jets appears to be declining. These changes have led to a temporary decrease in FAA workload at centers and towers; but, if the recent prediction of the beginning signs of recovery is accurate, growth will resume in the near future.

This near-term downturn in workload suggests that we could defer system modernization, but there are several reasons why that assumption is invalid. Operational improvements from capital investment often lag the appropriation of that funding by several years, because the complex equipment necessary to support improvements takes time to develop, build, install, test and finally use. Investment must anticipate future growth, because it cannot produce immediate results to respond to growth that has already materialized. Since flight delays in early 2008 were the worst in 8 years, the need for additional capacity will be evident shortly after growth resumes. If we do not schedule investment now, we will not be ready for recovery. In addition, the computer systems and other technology that we use for air traffic control have an estimated life of 10 to 20 years. For even some of the newer equipment, we will have to replace several system components in the latter part of the next decade. Without funding in these early years, we will not have contracts in place to provide the new equipment when it is needed. We also are committed to modernizing the existing air traffic control system rather than just replacing components. We need the Next Generation Air Transportation System (NextGen) to expand capacity to meet the needs of the future.

NextGen is not a copy of the current air traffic control system: it embodies a whole new concept for handling air traffic. It will allow individual flight paths to be assigned and controllers will seldom have to intervene when aircraft fly their assigned trajectory and hit the assigned waypoints at the assigned times. Real-time information on weather and traffic conditions will be available to all users, and we will solve conflicts collaboratively. We need NextGen for this to happen, and we need to start building it now.

6 Appendices

The CIP contains four appendices.

Appendix A

- Lists FAA strategic goals, objectives, and performance targets.
- Associates CIP projects with strategic objectives and performance targets.

Appendix B

- Provides CIP project descriptions and the relationship of projects to strategic goals.
- Provides the Strategic Management Plan (SMP) pathway and objective supported by projects.
- Lists FY 2010–2014 — performance output goals.
- Shows system implementation schedules.

Appendix C

- Provides estimated expenditures from FY 2010 through FY 2014 by Budget Line Item (BLI).

Appendix D

- Response to GAO Report 08-42 - Identifies programs with baseline changes and explains the causes of those changes.

Appendix E

- Defines acronyms and abbreviations.